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The development of a better understanding by the child of his natural environmental resources in the rural elementary schools of Sacramento County, California

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THE DEVELOPMENT OF A BETTER UNDERSTANDING BY THE CHILD OF HIS NATURAL ENVIRONMENTAL RESOURCES IN THE RURAL ELEMENTARY SCHOOLS OF SACRAMENTO COUNTY, CALIFORNIA

By

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THE PROBLEM

Introduction. This study was used in elementary science at the Rio Linda Union School, Sacramento County, California as an orientation course in the seventh and eighth grades to transform school science from a mysterious abstraction into an understandable, enjoyable and useful field of knowledge that is indispensible to a child's understanding of his environment. This is of value to the child especially during his out-of-school activities, which is so well brought out by McBee:

> .....the purpose of child study of nature is to put the child into intimate and essential contact with things of his external world, thereby developing a keen and personal interest in natural objects and phenomena of the world about him, broadening his horizons and developing his perceptions.[1]

These interests and activities of his immediate environment should develop, in time, in furthering science interests, appreciations and knowledges. As stated by McBee:

> The wider implications of nature study are concerned with opening the mind of pupils by direct observation to a knowledge and love of the common things in their

[1] O. B. McBee, Development of the Powers of Appreciations as Interpreted from the Standpoint of Landscape Architecture. (Master's Thesis, University of Oregon) 1937. 4-5.

environment, with increasing their joy of living.[1]

This is also clearly pictured by Downing who tells of the naturalist, J. Henri Fabre:

> There died but a few years ago, in France, a great naturalist, whose works the world is now reading with great delight---J. Henri Fabre, whom Charles Darwin called "the inimitable observer" and Victor Hugo, "the Homer of Insects". Fabre was not widely traveled. His life was spent in the south of France--the Midi--but he received honor the world over for his marvelous portrayal of the fascinating lives of insects, spiders, and other humble denizes of his home district, and for his keen philosophy based upon these observations. Fabre, though untraveled, has seen more in his own backyard than the average globe-trotter in all of his extensive journeys.[2]

Statement of the Problem. The problem of the study was: The development of a better understanding by the child of his natural environmental resources in the rural elementary schools of Sacramento County.

Due to the grouping of the grades seven and eight under one teacher in most of the rural schools,[3] the study covered only these two grades. The writer believes, through his experiences with younger students on conducted Saturday hikes, that rural schools of one-teacher size could also follow

[1] O. B. McBee, op. cit., 4

[2] E. R. Downing, Teaching Science in the Schools, 1929, 65.

[3] Leo F. Hadsall, "Suggestions to Teachers for the Science Program in Elementary Schools," Science Guide for Elementary Schools. I, 7 (Aug., 1934).

the general procedure with successful results.[1]

Whatever work was done had to be so set up that it would fall within the limits of the local natural environment. Then as interests developed the scope could broaden to meet individual interests, needs, knowledges and travel outside as well as in the immediate environment.

This study will not present a method of teaching nor a course of study, but will attempt to give a set of guiding procedures, information and findings which the writer hopes will be of some value and inspiration to teachers in developing a better understanding by the child of his natural environmental resources.

Importance of the Problem. The writer has sensed the need of a better understanding of their environment by children, through close contacts with them, and realizes that they know very little or see very little of their immediate environment except as they are directed to it.

> The interests of children are frequently haphazard and unorganized. Much must be done to develop and train those interests. In many cases a sense of awareness must be developed. Children often fail to appreciate the forms and abundance of natural phenomena in their own environment.[2]

[1] There are seventeen one-teacher and fifteen two-teacher rural schools in Sacramento County. These two types represent fifty percent of the rural schools in the county.

[2] Hadsall, op. cit., 1

> The child needs to be oriented to the environment.....[1]

> The mole, dwelling for centuries underground, lives without eyes, and seems content to dig on blindly forever. The child doomed to live always in the crowded city streets complains, after an entirely strange vacation in the country, that "It was alright (sic), but there was no place to play." Similarly, children condemned to grow up in a narrow school environment are cramped in physical, social, aesthetic, and even intellectural development. They never realize the breadth and richness of experience that might be theirs.[2]

Their understandings and interpretations are, in most cases, based upon superstitions and mystery, and limited by uninformed teachers and parents.

> Science has done much to dispel superstitions. It is common knowledge, however, that our literature and customs still bear glaring evidence of the prevalance and detrimental effect of unfounded beliefs. There is no other subject in the elementary school curriculum equally prepared to combat the traditional superstitions of an uninformed populace, and to train children in the practice of logically interpreting natural phenomena.[3]

[1] A. M. Gemmill, An Experimental Study At New York State Teachers College at Buffalo To Determine A Science Program for the Education of Elementary Classroom Teachers. (Teachers College Contributions to Education, No. 715) 33.

[2] John A. Hockett and E. W. Jacobsen, Modern Practices in the Elementary School. 124-125.

[3] Hadsall, op. cit., 1.

Scope of the Problem. There is no end of continued developments that may be the outgrowths of such a problem in the field of elementary science. But due to the lack of a definite program of science, time allotment, teacher interest and training, and science equipment in the rural schools of Sacramento County only plant, animal and inorganic nature were used.

The science study does not stand along within the curriculum but in addition to having units of its own it is also integrated with the social studies program. In most cases this was followed very rapidly and sketchily due to the teachers' lack of knowledge or interest in the field of science. Students who were to continue with their education would have a year of general science in high school which would cover more of the physical side of science and less of the biological phase.

Procedure. During the past six years the writer has been interested in the study of the natural environmental resources of California and their use in developing a better understanding by the child of his environment. In the seventh grade each year an orientation course was given, covering in a general way, all the phases of the child's natural environment. This course was organized while making a survey of community plants, animals, and inorganic materials which could be used.

Following the orientation course, which was one year in duration, was the course for the eighth grade given over to the development of certain phases of natural science that were of special interests to the class as a whole. There was always time allotted for individual interest and teacher help during the giving of both the above courses.

Helen Heffernan has mentioned this importance in all her discussions of the rural school child and his individual differences:

> No two human beings are ever alike. And so, the rural teacher is free from restraints to recognize the contribution of the child whose gifts are in his clever fingers, of the child who loves to explore the school library and bring to the group the treasures he has found, of the child who finds "Sermons in stones," of the child who sees life through the eyes of a poet.[1]

This study has been approached through an extensive survey of the following sources:

(1) An analysis of current literature in the field of education, recreation and science.

(2) An analysis of current articles in science periodicals.

(3) Survey of the natural environmental resources of Sacramento County.

[1] Helen Heffernan, Organization of Learning Experiences in Small Rural Schools, (Unpublished Bulletin by a Committee of the California School Supervisors' Association, Northern Section, 1938) Foreword.

(4) Conferences and committee meetings with Helen Heffernan, Chief, Division of Elementary Education and Rural Schools, California State Department of Education.

(5) Conferences with science instructors of San Jose Teachers College and Chico State Teachers College.

(6) Graduate theses and abstracts of theses which dealt with studies made in elementary school science, natural environment, techniques in developing courses of study, child's interests in nature, and teaching of science in the Horace Mann Elementary School.

(7) Yearbooks of the National Society for the Study of Education.

(8) Much valuable information was received by the writer while serving as a member of the California State Junior High School Science Curriculum Committee (1937-1939); the Oregon State High School Science Committee (Summer 1937); and, as Chairman of the Sacramento County Science Curriculum Committee (1935-1939).

(9) Research studies in nature study and environmental resources in the form of syllabuses, pamphlets, bulletins, courses of study from universities, state departments other than education, and public school systems.

(10) Collecting, identifying, and preserving by the author of plant and animal life of Mexico, California, and Oregon to be used in the study of the child's understanding of his environment.

Justification for the study of the Problem. During the writer's first months as a teacher in an elementary school in a mountain town (McCloud Junior High School, McCloud, California), it was noticed how little the children knew of their immediate environment. The abundant vegetation of pine, cedar, fir, dogwood, maple and chock-cherry; the wild flowers; water life of all varities; and insects of many kinds went unnoticed. The surrounding country was an unexplored wilderness; Mt. Shasta was taken as a matter of fact; mud-flow as an autumn horror, the ice-caves as black dungeons of death, and the lava beds as the home of rattlesnakes. No interest was shown in nature or its beauty as to its origin or its importance to the natural environmental changes over a long period of development.

Leo Hadsall brings this importance to light when he states:

> Too few people realize the importance of the beautiful in nature----It is not only the province of science to help the child to make adjustments to, but also gain a greater appreciation of his natural world.[1]

[1] Hadsall: op. cit., 2

Here was a community in the heart of natural museum with plants, animals and inorganic specimens in abundance; but nothing was, as yet, known about them. This is brought out by Hadsall in the following words:

> Beauty in and understanding of nature is available to everyone if he has eyes trained to see and ears trained to hear. It is the responsibility of the school to provide experiences that will develop appreciations to enrich the life of the child, now and throughout life.[1]

There was a need for leisure time activities because of the lack of work for the children at home or in the town on Saturdays or during the summer vacations. A class was formed within the school, under the direction and teaching of the writer, in elementary science to study the plant, animal and inorganic life of the local environment. This group developed into a class in science orientation, which was greatly needed because of the lack of science teaching throughout the elementary school system. Materials were collected by the students individually and in groups and by the writer after school and on Saturdays. As the specimens were brought into the class-room they were classified and arranged in interesting exhibits. The live animals were placed in cages and miniature natural habitats which were made by the students. Wild flowers were either put in

[1] Hadsall: op. cit., 3

glasses of water or pressed for study later during the year. As the interest increased so did the number of specimens which were brought in each day. The interest in the natural environment was not limited to the students in this one class, but began to take root in all classes within the school and also carried into the homes. Parents became much interested in learning of their natural environment as indicated by their frequent class-room visits, written inquiries and donations of collected specimens.

The need for the study of the natural environment is well stated by Edwin C. Broome in relation to the worthy use of leisure time of the adult as well as for the child:

> A love for any phase of nature, kindled in childhood, contributes greatly to the pleasures and recreations of later life. If we can awaken a permanent interest in flowers, trees, birds, butterflies, insects, etc., unworthy, degrading pleasures are not likely to find a very prominent place in the individual's life, for the young person will continue always to find "tongues in trees, books in the running brooks, sermons in stones, and good in everything".[1]

Much the same situation was noted in the rural elementary school of Sacramento County where this study was developed. The elementary science, if any were taught at all, was integrated into the social study units of work from time to time. Nothing was done with the animal, plant and inorganic materials of the immediate environment.

[1] Edwin C. Broome, Character Education in Elementary Schools, 16.

The possibilities of using the immediate environment for curriculum materials and child interests has been mentioned by Helen Heffernan and Gladys Potter during the last few years:

> The rural environment is a fortunate situation for realistic educative experience. The country around school is rich in real things, such as: animals, flowers and trees. The life of the rural community is simple enough for the understanding of a child.
>
> The rural school curriculum must find its orientation in the rural environment. Curriculum makers must face realistically the great variety of problems the rural school presents and design a pattern in terms of the actural situation. Enough time and energy has already gone into efforts to cut down an urban pattern to fit the rural school to demonstrate the effectiveness of such a procedure.[1]
>
> Teachers are aware of the vital interest of most children in both the biological and physical sciences. Their out-of-school educational activities are largely devoted to some first hand experiences with nature--- collecting, exploring, or experimenting. And yet in school experiences with nature study have been too frequently spasmodic or entirely neglected. Casual, incidental consideration has been given to materials brought in by children, seasonal discussions of flora and fauna or the spectaclar and unusual have been used occasionally as the subject matter for the nature study lesson.[2]

The writer has realized the need for science training in the rural elementary schools because of the educational, social, economical, and political changes that have so rapidly taken place in the last twenty years. Many writers in

[1] Helen Heffernan, Organization of Learning Experiences in Small Rural Schools, (Unpublished Bulletin by a Committee of the California School Supervisors' Association, Northern Section, 1938) Foreword.

[2] Gladys L. Potter, The Development of Understandings of the Scientific Environment. (A Prepared Paper, 1938) 22.

the field of education of the United States have brought out these same important changes of our modern adult world in which we live.

Due to the ever increasing use of machinery there is more and more leisure time for the child to be guided into useful channels of recreation. D. S. Farmer of the San Francisco State Teachers College makes the statement in the Sierra Educational News in regard to leisure time:

> Industrial changes have resulted in a greater amount of leisure time for the average individual. Science in the elementary school can be presented in such a way as to develop leisure interests which constitute both healthful and enjoyable means of recreation.[1]

There is a greater requirement placed upon the child to know more about his environment because of his ability to control and preserve as well as enjoy its resources.

[1] D. S. Farmer, "Camp Recreation", Sierra Educational News. Jan. 1939, 22-23.

CHAPTER II

A SURVEY OF THE TYPES OF SCIENCE TRAINING GIVEN IN THE RURAL ELEMENTARY SCHOOLS OF SACRAMENTO COUNTY, CALIFORNIA, AND IN OTHER STATES.

For the past four years there has been a growing interest in elementary science in the Sacramento County rural elementary schools. This interest appears to be more evident among the teachers than among principals and county superintendents.

The county science curriculum committee composed of five rural teachers and one county supervisor has made extensive studies of the content and method of teaching elementary science as done in other urban and rural schools of California and the United States. After the study was completed the findings and recommendations were presented to the county board of education, the county principals' association, and the county teachers' association. Nothing seemed to develop other than accepting the committee's report because of the lack of individual teacher training and interest, the county superintendent's great emphasis upon the 3R's and county examinations, and the principals' lack of knowledge and training of advanced work in educational changes over the last ten years.

A survey was made in Sacramento County to derive a clear picture of the number and size of rural elementary schools

and the time given each week to science teaching. The schools were grouped according to the number of teachers employed in each union school district.[1] Table I brought out the large number of one and two-teacher rural elementary schools in the county which is also typical of the state of California. Heffernan illustrates this in the following statement:

> In California there are more than 1500 one-teacher schools in our sparsely settled areas. In spite of our large metropolitan concentration of population, more than seventy percent of our schools are rural employing five or fewer teachers.[2]

The elementary science taught in the one-teacher to the nine-teacher size schools was largely a "hit-and-miss" type of science or an individual child's interest in the study of his local environmental habitat. Sometimes nothing would present itself, so no science would come into the curriculum for weeks at a time. Many specimens would be brought into the class room on the children's own initiative, but because of the teacher's or principal's prejudice or lack of interest, they were sent home immediately or at the close of the school day. So, in many schools the study of elementary science is still taken from a book which may not cover natural environmental resources around the local community.

[1] See Table I.

[2] Helen Heffernan, Organization of Learning Experiences in Small Rural Schools, (Unpublished Bulletin, 1938) Foreword.

TABLE I

SURVEY OF SACRAMENTO COUNTY

RURAL ELEMENTARY SCHOOLS

Teacher Size of School (#)	Number of Schools	Minutes of Science Teaching Per Week
One-teacher	17	0 to 15
Two-teacher	15	0 to 20
Three-teacher	7	0 to 15
Four and Five-teacher	10	0 to 20
Six and Seven-teacher	6	0 to 20
Eight and Nine-teacher	2	0 to 30
Ten to Fifteen-teacher	5	0 to 50
Sixteen to 23-teacher	3	0 to 75

(#) This grouping was used because of existing size schools in Sacramento County. The author's school was not included on this table.

> There is need for science materials relating to the western states. Most of the available materials have been prepared by eastern authors.[1]

This type of teaching reminds the author of a passage he once read about the reverence some have for authority found on the printed page when dealing with nature:

> In 1620 there convened in one of the great European universities a conclave of noted School-Men. The question arose as to the number of teeth that a horse possessed. These men went to the great university libraries and consulted the voluminous writings of Aristotle, Plato, Galen, and other authors of antiquity revered as the authorities on learning. They quoted this author and that as the discussion waxed hot. After five days of such investigation, a young novice suggested that someone go and look in the mouth of a horse and settle the question. The assembly was aghast at such audacity, such disrespect for the ancient authorities, and he was thrown out of the assembly. After two days of more fruitless attempts to discover an agreement in the old volumes consulted, the question was given up as hopeless, and this conclave of university professors agreed it never could be settled.[2]

The eight schools in the county with ten to twenty-three teachers covered many phases of elementary science. Very little was covered that dealt with all the different interests of the child and his natural environment. Under plants the study touched some wild flowers, a few weeks, leaf shapes of different trees, and the growing of domestic plants from seeds. The animal life took in some small mammals, a short study of birds, the life of the tree toad,

[1] Leo F. Hadsall, "Suggestions to Teachers for the Science Program in Elementary Schools," Science Guide for Elementary Schools. I, 7 (Aug., 1934).

[2] E. R. Downing, Teaching Science in the Schools, 65

very little on reptiles, and man's place in his universe. Many experiments were conducted by the teacher dealing with chemistry and physics. After these were observed by the children they were written up in their science notebooks.

In talking with the teachers who were doing the above type of teaching in the seventh and eighth grades, in almost every instance, the author observed that the children were not interested in science. The teachers mentioned how interested the children were in reading the new books on elementary science dealing with plants and animals of California that were sent out to the rural schools by the Sacramento County Library. (The same was brought out by talking to the science teachers in the Sacramento Junior High Schools.) Still these same teachers did not sense the possibilities of using the local natural environmental resources for an elementary science program. Heffernan brings this point out when she writes:

> The teaching of science in the elementary school has been neglected.....Teachers are aware of the vital interest of most children in both the biological and physical sciences. Their out-of-school educational activities are largely devoted to some first hand experiences with nature-----collecting, exploring, or experimenting. And yet in-school experiences with nature study have been too frequently spasmodic or entirely neglected. Casual, incidental consideration has been given to materials brought in by children, seasonal discussions of flora and fauna or the spectacular and unusual have been used occasionally as the subject matter for the nature study lesson. The reason for this is

> they have failed to sense and capitalize upon the many opportunities in the immediate environment for furthering science interest, appreciations, and knowledge.[1]

The only rural elementary school in Sacramento County that has a well rounded science program organized to study all the phases of the local natural environmental resources is the ten teacher school in which the writer has taught both the seventh and eighth grades for the past four years. One hundred minutes each week are given to elementary science study in both the seventh and eighth grades. Each grade is in a separate room because of the size of the school. The lower six grades have from ten to twenty minutes of elementary science each week devoted to the study of community natural resources depending on the teacher's interest and training in the field of science.

There are city, county and state curriculum committees working on courses of study for elementary science in California. As yet there is no agreement as to the content or grade placement of elementary science materials other than that it should take into consideration the child's local or immediate environment. The state has a very brief outline for science in the elementary school, but it is not used to any

[1] Helen Heffernan, The Integrated Curriculum in the Elementary School, (A Prepared Paper, 1938) 24.

extent or to any satisfaction.[1]

A study which covers the interests and needs of elementary science for the United States is well covered in the Thirty-first Yearbook of the National Society for the Study of Education. But even here there is no agreement as to what elementary science should include in its course of study. The scientific note has become very important in such realms of human activities as food, clothing, shelter, and recreation.

Thoughtful people are coming to hold the opinion that if the young people of our public schools are to understand their environment and be at home in it, a greater amount of material in natural science should be included in the program of instruction.

[1] Suggested Course of Study in Science for Elementary Schools, California State Department of Education, No. 13, Part I, (July, 1932)

CHAPTER III

THE CURRICULUM

A. Content: Science training or knowledge an elementary rural school child should experience in order to interpret and appreciate his natural environmental resources.

The author used the local natural environmental resources which were available to the children in their surrounding rural community. The children would become interested in their own community and through contacts with nature saw, studied, interpreted, understood, and appreciated its greatness. It gave many children an outlet for their increasing amount of leisure time created by our changing social and economic way of living. Many children enjoyed walking through the fields of wild flowers admiring their beauty and color, learning their common names, or picking one flower of each new species to bring home to press and later identify, or just being in the open with a group of fellow students. Others would prefer to spend their time near water holes, along the small running streams, or around man made reservoirs or lakes looking for water plants, insects, birds, nests, reptiles, fish, and amphibians. Several were interested in collecting rocks and minerals or asking questions about the solar system. Their interests in the living and growing natural environmental resources were very noticable.

Questions were asked daily by the students throughout the school in regard to the plant and animal life encountered on the field trips taken after school hours and on week-ends.

The preceding discussion will help to clarify why the author believes that children should have basic training and knowledge of their local environment, especially of animal and plant life. (See Table II on next page)

The survey[1] material was organized by the author of science possibilities in the local natural environment and then sent to the different schools in Sacramento County. This test was given to both the seventh and eighth grade children of the schools listed in Table II, but exclusive of both Chico and McCloud, California.

The following discussion is a continuation of this main theme, and supplemented with statements by authoritative teachers of science and nature study who believe that children should be oriented to their environment through the study of the local animal, plant, and physical resources.

The California State Junior High School Committee working on a new science program for the junior high school children

[1] Complete Survey used will be found in the Appendix

TABLE II

CHILDRENS' INTEREST IN THEIR

NATURAL ENVIRONMENT

Schools Studied (7 & 8 Grades)(#)	Number of Children Used		Natural Environmental Interests					
			Animal		Plant		Physical	
	B	G	B	G	B	G	B	G
Chico, California	20	23	12	11	5	8	3	4
McCloud, California	103	134	62	67	26	61	15	6
Rio Linda, California	210	247	123	124	63	96	24	27
Fruitridge, California	39	38	20	20	16	15	3	3
Del Paso, California	23	26	13	11	8	12	2	3
Arden, California	21	25	11	13	7	8	3	3
Robla, California	15	19	8	9	5	9	3	1
Enterprise, California	11	19	6	10	3	6	2	3

(#) McCloud, California was used for a two year period.
Rio Linda, California was used for a five year period.

of the rural and urban areas reports its aim in choosing science experiences for the "Early Adolescence" as follows:

> Science experiences at any age level should be primarily planned to bring children into contact with those scientific ideas and materials which have greatest significance for human living and thinking and which are of greatest interest to the children themselves. Particularly in the lower grades of the secondary school specialization and vocational expertness have no place as goals of learning. Our aim is rather to help children to become informed laymen, freed from the superstitions and misconceptions of our forbears, leading richer, happier lives because of improved understanding of themselves and the universe which science has given them, using the material resources of this world wisely and with due regard for future generations. To make a wise selection from the great body of knowledge, two factors must be kept in mind: first, the nature of the child; and second, the nature of the environment in which this child lives. Therefore, the child needs to be oriented to the environment. No selection of a special science will do this for him at such an early age. As problems arise and await solution, he must learn to take the materials he needs for his solution wherever he may find them. He must cross-section the fields of science. This, as we know from our experiences, is no new situation.[1]

Two major phases of science instruction, the enjoyment and appreciation of nature and natural phenomena, and the knowledge and appreciation of the scientific method, should function effectively in choosing material from the local environment to be studied. The purpose of science teaching in the elementary school is not so much "in starting boys and girls on the road to becoming scientists and naturalists

[1] Teachers' Guide to Child Development in Early Adolescence. California State Department of Education. (Unpublished 1937) Chapter V.

as training them to become educated laymen."[1] Science experiences should be satisfying, varied, and stimulating to insure the accomplishment of such a purpose. The child should be led into the realization of his responsibilities, the intelligent use of his own life and his natural environment, and to appreciate the beauty and mystery of nature.

From the standpoint of content:

> The greatest contribution from the field of science to the educated layman is better understanding of himself and the universe in which he lives. Study of the structure, functions, and behavior of all living things gives perspective and provides background for better understanding of human beings. Children can learn something of human development in general and be able to evaluate more objectively their own approach to maturity through biological phenomana. They can learn a simple, accurate vocabulary relating to human functions and with this as a tool be freed from the unreasoning fear of "mysteries" of life of which they feel adults are denying them knowledge. Study of the inter-relations of living things, their change through time, and their dependence on the non-lving in an orderly universe, a philosophy of life adequate to meet changing knowledge and new ideas. This is strengthened by studying the structure of the physical universe and its changes through time, the development of our ideas of the world on which we live and its relations to the other parts of the universe.[1]

Now is the time to offer opportunity for exploring a wide variety of avocational and vocational possibilities.

[1] Gerald S. Craig, Certain Techniques Used in Developing a Course of Study in Science for the Horace Mann Elementary Teacher's College. (Teachers College Contributions to Education, No. 276) 6

[2] Teachers' Guide to Child Development in Early Adolescence, California State Department of Education, (Unpublished 1937) Chapter V.

The field of science is abundant with suggestions of things to do or study in leisure time. Science experiences are inadequate if children do not develop skills and interests along these lines. Suggested hobbies are: the raising of plants and animals; collecting of plants and animals; construction of cases, winter gardens, and needed projects to house live plants and animals brought into the class room. These are enriched by knowledge and skills technically labeled scientific.

The science training or knowledge should be broad rather than specialized in scope:

> It must be extensive enough to insure that the child has an acquaintance with the identify and habits of the biota-----birds, mammals, fish, insects, reptiles, amphibians, fresh water animals, salt water animals, flowers, trees, and other plants-----of his environment. He needs a knowledge of the factors of heredity, the broad concept of development---evolution---, man's place in the living world, the interrelation-ships between organisms, and the principles of good conservation. Actual field experience is essential in order to have a real comprehension of living things. He should have an accurate conception of our universe and of the origin and development of this earth on which we live: the rocks, minerals, fossils, and land forms.[1]

In planning any adequate science program, five fundamental principles should be followed:

> 1. The material should belong to the activities and experiences of childhood, and to the child's biological and physical environment, leading from the familiar to the unknown.

[1] Teachers' Guide, op. cit., Chapter V.

2. The material should arouse the interest and curiosity of the child, and at the same time, be such that he is able to see and determine most of the facts for himself.

3. As soon as the child's interests and comprehension make it preferable, material having social value should be given preference over that which is interesting for itself alone.

4. The material should be seasonal.

5. The material should form a progressive and unified course and should be of sufficient variety to afford as broad an outlook of the child's environment as the four principles just stated make practicable.[1]

The author has also observed during his teaching of science to seventh and eighth grade children in rural and mountain areas that a great number of children finished their formal education upon graduation from the eighth grade. If they were denied the opportunity to study their surrounding environment they would start adult life without knowledge of nature and an appreciation of beauty and the resources of nature.

There is a common agreement among teachers, laymen, and children (See Table III), that science or natural environmental interests come in the following importance:

I. Animals

II. Plants

III. Physical Materials

[1] C. R. Stone, Supervision of the Elementary School, 451-456

TABLE III

INTERESTS OF CHILDREN

Schools	Animals	Plants	Physical
Chico, California	54%	30%	16%
McCloud, California	55	38	9
Rio Linda, California	53	35	12
Fruitridge, California	54	40	6
Del Paso, California	51	40	9
Arden, California	53	35	12
Robla, California	50	41	9
Enterprise, California	55	30	15
Average	53.1	36.1	10.8

Much to the surprise of the author it was found after completion of the survey that his findings agreed with those taken by other science teachers in other parts of the United States. This was brought out in both Table III and in Table IV of this chapter.

A survey by E. L. Palmer revealed that the science questions and interest of children enrolled in country or rural schools of New York State for five years were:[1]

Animals	66.8%
Plants	21.1
Physical	5.8
Agricultural	4.0
Misc	2.3

The breakdown of the "Big Four" further revealed:

ANIMALS

Invertebrates	21.1%
Birds	18.4
Mammals	13.6
Reptiles	6.1
Amphibians	5.9
Fish	1.6

PLANTS

Trees	12.3
Flowers and Herbs	7.6
Fungi	1.2

[1] E. L. Palmer, "The Science Interests of Children Enrolled in Country or Rural Schools of New York State," The Nature Study Review, XVIII, 32 (1922)

PHYSICAL

Geology	1.9
Meterology	3.4
Astronomy	.5

AGRICULTURAL

Crops	2.8
Gardening	1.2

In a recent survey made by George W. Hunter[1] among Santa Monica Schools, he recorded the following interest chart:

STUDENT INTEREST

Boys			
Birds	128	Flowers	148
Animals	105	Birds	122
Flowers	72	Animals	63
Stars	49	Stars	45
Rocks	48	Rocks	28
Trees	30	Sea Life	25
Sea Life	22	Trees	23
Fossils	19	Fossils	12
Reptiles	14	Insects	11
Insects	10	Reptiles	2

An additional survey, "to find what nature topics the students knew the most about in the Santa Monica Schools" revealed:

STUDENT KNOWLEDGE

Boys		Girls	
Birds	110	Flowers	127
Animals	92	Birds	91
Flowers	60	Animals	70
Stars	45	Stars	43
Trees	37	Trees	38

[1] George W. Hunter, Science Teaching at the Junior and Senior High School Levels, 69-70.

Rocks.....	35	Rocks.....	20
Sea Life....	29	Sea Life.....	17
Fossils.....	15	Fossils.....	16
Reptiles....	15	Insects.....	10
Insects.....	12	Reptiles.....	4

The author noted during his teaching experiences of science that the above interests of children are quite general throughout Siskiyou, Butte, Sacramento (See Table IV), and Alameda Counties in California.

Live animals and plants attracted more interest and attention by the children of their rural environment than did physical materials. They liked to watch things grow, to touch them, to hold them, to get close to them, and to feel they were a part of the environment. As more information was given about their environment a decided change developed in their desires to hike into the country or woods during weekends.

The amount of nature study or science material of the local environment that was brought to school by the children increased daily. Instead of saying:

> "There are no frogs, lizards, snakes, or water dogs around here," they said:
>
> "We found a new pond just full of water dogs and frogs."
>
> "You should see the swell place I found just covered with moss and ferns. We can make plenty of balanced winter gardens now."
>
> "I found a large moth last night out by the old saw mill."

TABLE IV

STUDENTS' INTERESTS OF
SACRAMENTO COUNTY,
CALIFORNIA

Boys	Rank	Girls	Rank
Amphibians	1	Wild Flowers	1
Reptiles	2	Insects	2
Wild Flowers	3	Birds	3
Insects	4	Amphibians	4
Small mammals	5	Rocks and Minerals	5
Birds	6	Trees	6
Trees	7	Sea Life	7
Sea Life	8	Water plants	8
Water plants	9	Reptiles	9
Rocks and Minerals	10	Astronomy	10
Astronomy	11	Fossils	11
Fossils	12	Small mammals	12
Atmosphere	13	Atmosphere	13

"I'm going to press and identify two new butterflies I caught for my insect collection."

You can readily see how interest in a given locality can increase. Once the children "capture" the idea that they have a personal interest at "stake" they are anxious to uncover added mysteries of their natural environment.

The author used the scientific terms for group headings because teachers and children needed this information if they were to use reference books. This made it easier for them to find the family group from which they could work to a certain species that they were doing research. The following fields of science have been used by the author to introduce the natural environmental resources needed by the child to interpret, understand, and enjoy his local surroundings:

A N I M A L S

I. Protozoa: (Single celled)--(If a microscope is at hand).

II. Coelenterata: (#)[1]

III. Sponges: (#)

IV. Roundworms: (Nemathelminthes).

V. Wheelworms: (Trochelminthes)--(If a microscope is at hand).

VI. Segmented Worms:

[1] Fields of science marked with a(#) were included because children did a great deal of travelling during the summertime and brought back such specimens. (See Table V).

VII. Echinodermata: (#)

VIII. Arthropods: (Invertebrates).

A. Crustacea: (#)

B. Arachnids:

C. Millipeds:

D. Centipeds:

E. Insects:

IX. Molluscs: (#)

X. Chordata: (Vertebrates).

A. Amphibians:

B. Reptiles:

C. Fish: (Fresh and salt water)--(#)

D. Birds

E. Mammals: (#)

P L A N T S

I. Thallus Plants: (Thallophytes).

A. Algae:

1. Green Algae: (Ife you have a microscope at hand).

2. Brown Algae: (#)

3. Red Algae: (#)

B. Fungi:

1. Bacteria:

2. Yeasts:

3. Bread Mold:

4. Water Mold:

5. Sac Fungi:

6. Toadstools, puffballs, and mushrooms:

C. Lichens: (#)

II. Bryophytes:

A. Mosses: (#)

B. Liverworts: (#)

III. Pteridophytes: (Spore Bearing Plants)

A. Ferns: (#)

B. Horsetails:

C. Club Mosses: (#)

IV. Spermatophytes: (Seed Plants).

A. Conifers: (#)

B. Common Seed Plants:

P H Y S I C A L

I. The Earth: (A planet).

II. Astronomy:

III. Seasons:

IV. Atmosphere: (Air).

A. Composition:

B. Pressure:

C. Light:

D. Heat:

E. Warming of land, water, and air:

F. Temperature changes:

G. Water forms in the atmosphere:

H. Winds and storms:

I. Weather and climate:

V. Hydrosphere: (Water on the earth).

A. Oceans: (#)

B. Lakes: (#)

C. Rivers:

VI. Lithosphere: (Crust of the earth).

A. Minerals and metals: (#)

B. Rocks: (#)

C. Soil:

VII. Fossils: (#)

Each field of science will be developed more fully in a later chapter. (See Chapter IV) Time allotment, teacher interest and enthusiasm, seasonal changes, and other conditions are the controlling factors in determining how much of the listed content can be covered in the upper grades of the child's elementary school life. This program was followed in the seventh and eighth grades in rural schools, the upper elementary grades in small communities, and junior high schools in larger cities. In actual practice more time was given to animal and plant life than to the physical side of science. This was due to children's interest and the great abundance of natural animal and plant life near the school and the home.

TABLE V

WHERE CHILDREN OF SACRAMENTO COUNTY SPEND THEIR VACATIONS

Area	Boys	Girls	Total
At home---Sacramento, County.....	46	51	97
Mountains, Lakes, Foothills.....	23	43	66
San Francisco--Bay Area.....	10	20	30
Sacramento Valley--Out of the County..	9	14	23
Sea Coast.....	9	10	19
Other States than California.....	2	8	10
Southern California.....	3	3	6

B. Method of Teaching: How the teacher or nature leader should provide an elementary rural school child with the necessary natural environmental knowledges and experiences.

Helen Heffernan brought out the importance of using the rural environment in selecting the content and in using it in terms of pupil activities:

> The rural environemtn is a fortunate situation for realistic educative experiences. The country around the school is rich in real things-----animals, plants, minerals, rocks, and other physical materials. The life of the rural community is simple enough for the understanding of a child.
>
> All learning must be viewed in terms of pupil activity. The activities of the teacher are important only in so far as they help children to select carefully and complete desirable experiences successfully. Children learn by doing.[1]

There are two methods which may be used in presenting the natural environmental resources to the child, according to leading men in the field of scientific research. Method I is more formal, while Method II is more informal.

METHOD I

A. Selection of the science activity.
B. Planning the science activity.
C. Introducing the science activity.
D. Conducting the science activity:
   1. The problem method.
   2. Use of casual science material contributed by the children.
   3. Experimentation.
   4. Class excursions or field trips.
   5. Keeping records.

[1] Helen Heffernan, Organization of Learning Experiences in Small Rural Schools, (Unpublished Bulletin, 1938) Foreword.

6. Collections.
7. Projects.
8. Correlation with other subjects:
   a. Arithmetic.
   b. Art.
   c. Reading.
   d. Oral expression.
   e. Writing.
   f. Manual arts and construction.
   g. Music.
   h. Plays and games.
   i. Social experiences.[1]

METHOD II

A. Work is to be kept simple. Technical terms are to be eliminated.
B. Materials to be used are those to be found available according to time, place, and immediate interest to the child.
C. The method of presentation should be such that the teacher is a member of his or her own class, inspiring the children with his or her own example as a learner.
D. The points to be considered in the study of each specimen should include:
   a. General and special features of appearance.
   b. The home or the habitat.
   c. Food and manner of obtaining the same.
   d. Enemies and protection against them.
   e. Comparison with others of its class.
   f. Economic use or importance to man.
   g. Cultural method if desirable.

E. Have a nature study room or nature study corner in the room of each school.

[1] Leo F. Hadsall, "Suggestions to Teachers for the Science Program in Elementary Schools," Science Guide for Elementary Schools, I, 8-21 (Aug., 1934).

F. Frequent excursions with specific objects in view are recommended. Such excursions may be to the sea shore, parks, farms, weed patches, roadsides, along a river or stream, in the mountains, or in the open country.

G. Consideration should be given to:
   a. The orderly notebook.
   b. The collection of natural environmental specimens.
   c. The exposition-----pet show, flower show, arrangement of life story in display of material.
   d. Keeping in the room of aquariums, winter gardens, terrariums, and prepared dead specimens.
   e. Class reports and discussions.
   f. Reading, study, and use of reference material.
   g. Nature study clubs and hiking clubs.
   h. Determine the local problem and study it.[1]

The author finds that a combination of the two above methods of procedure is more successful than to use either one separately. The teaching of natural environmental resources should be very flexible, in order that the science program may meet environmental changes and materials due to season, weather, and the school program.

The teacher's daily program should be planned so that a few minutes can be given to science materials brought in by the children. This is important. Only a few minutes of

1 E. C. Moore, Minimum Course of Study, Report of Committees on Minimum Essentials in Elementary Education, (N. Y., 1922) 6.

class time is required. The child should have his science collection, material, or discoveries noticed by the teacher and his fellow class members. Individual recognition creates added interest. Additional time may be given to this science material after class, during the noon hour, after school, or during the science club meeting. Always notice any child's contribution to the school's science collections, even if it is not related to that unit of science study which the class is working on at the moment.

Special study should be cultivated among those boys or girls who show a keen interest in science and having added leisure time on week-ends or summer vacations. This may prove beneficial if a student follows this course of study in institutions of higher learning.

This is brought out by Elliot R. Downing when he writes:

> The average boy whom we teach in our public rural school is destined to lead a rather monotonous existence either in his rural or urban adult life. He does not have the stimulus of travel. If he is to see the marvels of the world, there must be revealed to him the marvels in his own immediate environment. It is the function of science instruction to open the eyes of average boys and girls to the wonders that lie all about them. We cannot make scientist of every school child, but we can reveal the significance of the commonplace environment to him.
>
> Give the child some appreciation of the beauty of the stone he picks up to throw, and his environment comes to have a new meaning.[1]

[1] Elliott R. Downing, An Introduction to the Teaching of Science, 65-69.

The author would like to reiterate that in science training, especially, there should be a relationship of sympathetic understanding between students and the teacher. This is essentially true on field trips.

To obtain the maxium interest on the part of the boys and girls, encourage the students to "explore" and bring new plants, insects, bugs and flowers to the classroom. In this manner the student feels that he has a definite role to perform in the daily classroom program.

The orientation of the child to the various phases of science will be outlined and discussed in the following chapter. The author will describe his findings and conclusions reached through this orientation course.

CHAPTER IV

THE ORIENTATION COURSE

Chapter three dealt with a brief outline of the content and methods used in developing a nature study program. The orientation or survey course will be developed very extensively in chapter four in order to give the teacher a working background as well as a definite plan to follow in teaching the nature study program of the child's natural environment.

The orientation or survey course, to be of any value, should be broad in its interpretation. It should do several things for the child. Not only should it give information concerning the world of science, it should develop a lasting interest in science and a love for it. If the generalizations of science are wisely selected and well taught, there should result a growing realization on the part of children of the value of science in interpreting their local environmental resources. The orientation course should give the children a broader outlook of their natural environmental resources and on life within their community.

For the purpose of introducing the children of the upper elementary grades, (seventh and eighth grades) a broad overview course in science was found useful. An overview course must sample all fields of science and bring to the child a certain familiarity with scientific knowledge and method.

The orientation course was conducted in the seventh grade classes which met two one hour periods each week for one year. These periods were supplemented by afterschool and Saturday meets and hikes.

The following outline was used over a period of eight years by the author with successful results:

INTRODUCTION

> "You must not know too much, or be too precise or scientific about birds and trees and flowers and watercraft; a certain free margin, and even vagueness--perhaps ignorance, credulity--helps your enjoyment of these things, and of the sentiment of feather's, wooded, river, or marine Nature generally." -----Whitman.
>
> Man is a creature of nature; his home is nature; what he is and has, he obtains from nature. It is his privilege, itself a gift of nature, then, to be able to use, to enjoy, and to profit by all of nature's varied and wonderful offerings to the fullest possible extent.[1]
>
> It is his privilege to discover, to interpret, to know, understand, and appreciate the varied and intricate phases of nature, its forms, features, and foibles, as they are presented to his senses, to his eyes and ears and sense of smell and the touch of his hands.[2]

[1] Louis Wessel, Course in Nature Study for Adults, (Master's Thesis, University of Oregon) 1932, 8.

[2] Ibid.

Our World

I. Dead Materials:

A. Rocks and Minerals.

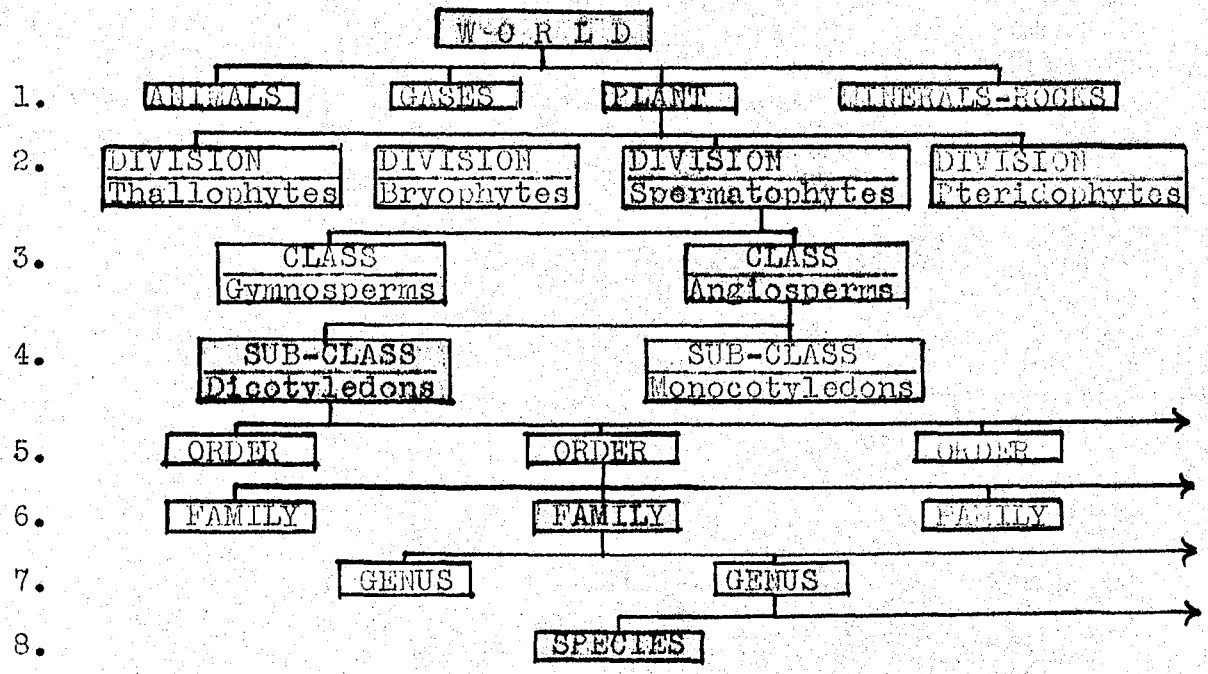
B. Gases.

II. Live Materials:

A. Plants.

B. Animals.

Classification[1]
(A Plant)



[1] The above classification was included because many children as well as teachers are interested in the scientific classification of plants and animals.

The Living World

Life cannot exist without: warmth, water, food, and air.

I. Life zones:

A. Because of differences in heat and in moisture, and perhaps other things, the north and south sides of hills and mountains are apt to show decided difference in life forms.

B. Life is found in more or less distinct zones:

1. Redwoods occur in a narrow belt along the Pacific coast.
2. Sugar Pine is confined to a thin zone in the Sierras and Cascades, a thousand feet or more in depth, which parallels timberline some 3 or 4 thousand feet below it.
3. Cottonwoods form definite belts along streams and lake shores.
4. Quaking Aspen is found from coast to coast, from the Arctic to the Tropics, and from sea level to timberline.

5. Monterey and the Torrey pines are found in nature over very restricted areas on the California coast.
6. Duck weed is found in fresh waters of all continents.
7. The Road-Runner is found only in the arid southwest.

II. Migration of Life Forms:

A. Like people, plants and animals are prone to migrate; and, as people do, plants and animals find certain barriers which they cannot cross. (New means of transportation have diminished many of these barriers today).

B. In the Pacific Coast staes, upward of 600 species of exogenous plants have found a new home.

C. As the white man has crowded back the native population, so the plants that he brought along with him, either intentionally or other wise, have crowded out the native species.

1. Acres and acres of land have been taken over by Queen Ann's Lace

(the lowly garden carrot), the Plantains and dozens of other species.

2. Canadian Thistle has spread its tenaciously matted roots through whole farms, and even whole communities.

3. The Foxglove turns entire mountains red, pink or white in color.

D. The Common House Mouse and House Rat were unknown to the Indians, they came from Europe.

E. Where the Bison and Lynx fell before the advance of civilization, the Horse, Burro, and Domestic Cat have gone wild and again become a part of nature.

F. Chinese Pheasants, Hungarian Quail, Starling, and English Sparrows are in a small way filling the void left by the vanished Passenger Pigeon and Heath Cock, and the disappearing Cranes, Swans, Egrets, and many other native birds.

G. One may in the same stream on the same day catch fish whose ancestry dates back to Loch Leven, Lake Geneva, Lake Champlain, and Lake Winnebago.

III. Some Characteristics of Animal and Plant Life:

A. The Plants and Animals of today are intimately bound up with those of yesterday and "yesteryear", as well as with those of the dim past.

B. A tree stump tells where once stood a giant, felled ten, or fifty, or perhaps a hundred years ago.

C. The shells, lines and impressions found in rocks, often thousands of feet below the surface of the earth, tell of life that existed hundreds of thousands or millions of years ago.

D. The animal life is dependent either directly or indirectly upon plant life for its subsistence, for animals cannot, like plants, drive their food from raw materials of the earth, sea and air.

E. Most animals live directly upon vegetable material; the rest live upon other animals, which in turn either directly or indirectly live upon plant life.

F. Man derives his sustenance from plants as the ultimate source, whether he reaches

it indirectly through a juicy T-bone, a dainty omelet, a dozen oysters raw on the half shell, or directly through the lowly potato.

IV. Life considered in its aesthetic values:

A. Man is interested in the animate world not merely for the sake of the materials of sustenance and shelter and comfort that it provides for him.

B. Each plant and animal is of some interest to some one, and to be interested in a thing is to enjoy it.

C. Plants spread rich verdure over the hillsides with fragrant flowers and luscious fruits.

D. Animals stir it into activity.

E. The highest aesthetic values are probably not those which lend themselves to depiction upon paper or canvas or in marble, but rather those which are realized in motion and activity.

ANIMAL LIFE

Introduction

I. Distinctions between Plants and Animals:

A. To the casual observer, the question of the difference between a plant and an animal presents no special difficulty. To him a plant means something like a tree or a grass or possibly even a moss, and an animal is something that moves about.

B. He is probably not quite so sure that a toadstool is a plant and that a sea anemone or a sponge is an animal.

II. Classification of Animal Life:

A. All animals may be classified into two groups:

1. Invertebrates: No internal skeleton backbone.

a. Protozoa.

b. Porifera.

c. Coelenterata.

d. Flatworms.

e. Roundworms.

f. Wheelworms.

g. Echinodermata.

h. Annelida.

i. Arthropoda.

j. Mollusca.

2. Vertebrates: an internal skeleton or backbone.

a. Pisces or fish.

b. Batrachia or amphibian.

c. Reptilia or snake.

d. Aves or bird.

e. Mammalia or mammal.

f. Man (one species of mammal).

III. Animal Remains in Ancient Deposits:

A. That there actually was a more or less regular succession of life forms upon the earth is fully substantiated by a study of the structure of the earth's crust.

B. Much of the crust is formed of layers of sand and clay laid down in water.

C. The lowest layers were laid down first: and peculiarly enough the lower the position in which a layer is found and the earlier its history, the more primitive the forms of life it reveals.

D. The very lowest and oldest layers of rocks contain remains of the simplest invertebrates.

E. Remains of mammals and of birds are found only in the comparatively much more recently laid down rocks, while those of man occur only in the most recent.

F. The first forms of plant life were of a simple and low order, and that such highly developed forms as our nut-bearing oaks and walnuts and fruit-bearing grapes did not appear until recent geological times.

Protozoa

I. General Characteristics:

A. Protozoa means "First Animals."

B. Simplest form of animal life.

C. One-celled animals.

D. Mostly microscopic.

E. Active and only lives in wet places.

F. There are over 15,000 known species.

II. Parts of a one-celled animal:

A. Cell wall.

B. Protoplasm (liquid within the cell wall).

1. Cytoplasm--liquid.

2. Nucleus--life or heart of the cell (dark spot).

3. Vacuole--food or water bubble.

III. Types of one-celled animals:

A. Amoeba.

B. Paramecium.

C. Euglena.

D. Vorticella.

E. Plasmodium malariae.

F. Stentor.

IV. Life History:

A. Reproduction:

1. Cell division--Asexual.

2. Conjugation--Sexual.

B. Habitat:

1. Fresh or salt water.

2. Damp places.

3. Found in drinking water that has not been purified by chemicals or by boiling.

4. Many are found in the blood system or body cavities of animals:

a. Malaria carrying protozoa.

b. Food digesting protozoa of the termite.

5. Remain on dry grass or other plants in a dormant stage until a wet season comes or until water is present.

V. References:

A. Science Guides:[1]

Culbertson, A. E. How Living Things Get Air, Vol. III, No. 3, October, 1936

Duncan, C. D. Termites, Vol. V, No. 9, April, 1939.

Reid, Lea. Fresh Water Aquaria, Vol. 2, No. 10, May, 1936.

B. Books:

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Hunter, George W. Problems in Biology, 1935.

Kinsey, Alfred C. New Introduction to Biology, 1933.

[1] Science Guides for Elementary Schools, California State Department of Education. Vol. I-V, 1934-1941. (These bulletins are sent free to every California School).

Porifera or Sponges

I. General Characteristics:

A. Sponges have many unusual shapes:

1. Round.
2. Flat.
3. Fan shaped.
4. Long.

B. Most sponges are grayish in color. Some are greenish.

C. There are over 3,000 species of sponges.

D. Sponges consist of many circular holes or pores through which food and water is absorbed. Food is also thrown out these same pores.

E. Some are very small while others are as tall as a man.

F. Sponges are collected by man, the most common known is the bath sponge.

G. Their food consists of miscroscopic plants and animals.

II. Types of sponges:

A. Bath sponge.

B. Venus's-flower-basket.

C. Fan sponge.

D. Sycon.

III. Life History-----Reproducation:

A. Produce sperm cells and egg cells at different times.

B. The young sponge is free swimming.

C. After they pass through the different stages of youth (a form of metamorphosis) they become attached to a rock and become an adult growing sponge.

IV. Habitat:

A. Found in fresh or salt water.

B. Fresh water sponges are never more than one inch thick.

C. Found at all depths in the sea or ocean.

D. The adults are always attached to some "anchorage". They cannot move about.

E. The larger sponges are found in warm salt water in the tropical zone.

V. Economical Importance:

A. Bath sponges.

B. Padding for coats.

VI. References:

A. Science Guides:

Wells, H. Tide Pool Animals, Vol. 2, No. 1, August, 1935.

B. Books:

Arnold, Augusta Foat. The Seabeach at Ebb Tide, New York: The Century Co., 1901

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Curtis, F. D.; Caldwell, Otis W.; and Sherman, Nina H. Everyday Biology, Boston: Ginn and Co., 1940

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Powers, S. R.; Neuner, E. F.; and Bruner, H. B. This Changing World, Boston: Ginn and Co., 1934.

Ricketts, E. F., and Calvin, J. A. Natural History of Pacific Shore Invertebrates, Stanford University, California: Stanford University Press, 1935

Russell, F. S. The Seas, New York: Fredrick Warne and Co., 1928

Coelenterates

I. General Characteristics:

A. Coelenterate means "Hollow intestine".

B. There are over 4,300 species.

C. Are bags of living material.

D. Each has a single central cavity through which the food materials, wastes, and reproductive cells are carried.

E. Capture and kill their food by means of thread-like tentacles.

F. Most of these animals look like plants.

G. The mouth is at the upper end of the longish round body.

H. Higher stage of development than the sponges:

1. A single opening into the body.

2. A central cavity in which digestion takes place.

II. Types of Coelenterates:

A. Hydra (fresh water).

B. Sea Dahlias.

C. Sea Gooseberry.

D. Jellyfish.

E. Sea Anemones.

F. Coral.

III. Life History-----Reproduction:

A. Asexual as in the hydra by budding. The young hydra brakes off from the parent and starts adult life itself.

B. Sexual reproduction takes place within the body cavity of the adult:

1. Sperm develops near the opening or mouth and is free swimming.

2. Eggs develop near the base of the body cavity still attached.

3. Eggs are either kept attached to the parent until developed or are thrown off to shift for themselves after fertilization.

IV. Habitat:

A. The hydra lives in fresh water. Most of them are green in color.

B. The rest of the Coelenterates live in salt water.

C. Live on small plant and animal life.

V. Economical Importance:

A. Of very little value because they are 90% water and are not used as food.

B. Coral is of value in building coral reefs and in making jewelry.

C. Many are very beautiful to look at and study.

VI. References:

A. Science Guides:

Johnson, M. E. West Coast Marine Shells, Vol. 4, No. 9, April, 1938.

Reid, Lea. Fresh Water Aquaria, Vol. 2, No. 10, May, 1936.

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Ricketts, E. F., and Calvin, J. A. Natural History of Pacific Shore Invertebrates, Stanford University, California: Stanford University Press, 1935.

Flatworms

(Platyhelmenthes)

I. General Characteristics:

A. Usually very small. Are ribbon like, leaf-like, or flat.

B. Most flatworms are parasitic. (Live on other creatures or hosts.)

C. Many have no digestive tracts.

D. Very little sense organs.

E. There are 5,000 known species.

F. Their bodies are soft, thin, and flat.

G. Bodies made up on three layers.

H. Can crawl from place to place.

I. Many have well developed reproductive, excretory, muscular, and nervous systems.

J. Human beings are infected either by uncooked food or by dirt getting into the mouth.

II. Types of Flatworms:

A. Non-parasitic flatworms.

B. Liver fluke.

C. Tapeworms.

III. Life History-----Reproduction:

A. Tapeworms:

1. Eggs swallowed by cow, pig, or fish along with food or water.

2. Hatches and bores into blood stream where it is carried into the muscles.
3. When the meat is eaten by man, and not cooked well, it continues to develop into adult stages in the intestines.
4. Eggs are in old parts of tapeworm that have broken off and are passed out of the body with the waste materials.
5. Eggs are eaten by pig, cow, or fish and so the life cycle is carried on.

B. Liver fluke:

1. Eggs eaten by sheep.
2. Eggs develop in sheep and carried out in waste material.
3. Next host is the snail which it leaves as a free swimming organism.
4. Back to land and remains to be eaten again by the sheep.

IV. Habitat:

A. Intestinal track, liver, and muscles of animals.

B. Lives in the ground and fresh water part of the time.

C. Snails are very important during stage of liver fluke's life history.

D. Live in salt water, fresh water, and moist places.

V. Economical Importance:

A. Of no value to man and causes a great deal of loses both in money and life.

VI. References:

A. Books:

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Roundworms

(Nemathelminthes)

I. General Characteristics:

A. More complex than flatworms.

B. Roundworms have a food tube, or alimentary canal, which lies in a body cavity.

C. Variation in size from icroscopic to over two feet long.

D. The most important species are parasites of plants and animals.

E. The adults are always wormlike.

F. Their bodies are not divided into segments.

G. The most common known and collected is the horse-hair snake of the mud-puddles or watering troughs.

H. An animal like the horse has been known to be infested with several millions of these parasites.

I. There are over 15,000 know species of round-worms.

J. These worms cause great injury to health and cut down the efficiency of human energy.

K. Most roundworms are whitish in color.

II. Types of Roundworms:

A. Hookworms.

B. Trichinella which causes trichinosis.

C. Ascaris a parasite of the lower intestines.

D. Tapeworms which are found in the windpipe of young chicks.

E. Spinehead worm.

F. Arrow worm.

G. Vinegar ells.

H. Horsehair snakes or worms.

III. Life History-----Reproduction:

A. The worms hatch in damp places from eggs which have been eliminated with animal feces or waste.

B. They enter their host by many ways:

1. Through the barefeet of humans into the blood stream. Are carried by the blood stream to the lungs. Up the windpipe to the mouth and are then swallowed. They finally become attached to the intestines where they suck the blood from the host. As the eggs are eliminated they drop to the ground and the life cycle continues.

2. Pork that has not been well cooked contains trichinella which causes trichinosis.

C. Ascaris which lives in the lower intestines of young children, pigs, and dogs are taken through the mouth.

IV. Habitat:

A. Live in moist places, fresh water, and salt water.

B. Live in the body of most large animals.

C. In soil that has been polluted by human waste.

V. Economical Importance:

A. No value to man or the world. (Economic waste)

VI. References:

A. Books:

Corwin, M. J. and Walling. The Science of Plant and Animal Life, San Francisco: Harr Wagner Publishing Co., 1931.

Curtis, F. D., and Others. Everyday Biology, Boston: Ginn and Co., 1940.

Hunter, G. W. Problems in Biology, New York: American Book Co., 1935.

Kinsey, A. C. New Introduction to Biology, Philadelphia: J. B. Lippincott Co., 1933.

Rotifer or Wheelworms

I. General Characteristics:

A. Very small miscroscopic animals rarely more than one-third of an inch long.

B. Has a ciliated area at the anterior end of the body which serves as a means of locomotion and to bring food to the mouth.

C. There are about 1,500 known species.

D. Rotifer means "wheel-bearer".

II. Habitat:

A. Found in fresh water.

B. Are either free swimming or attached to stones or water plants.

C. The eggs lay dormant on dry grass until they are put in water.

D. Takes about nine days for eggs to hatch and are found in the surface scum of ponds.

III. References:

A. Science Guides:

Reid, Lea. Fresh Water Aquaria, Vol. 2, No. 10, May, 1936

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Needham. Guide to the Study of Fresh-water Biology, Ithaca: Comstock Publishing Co., 1920

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Echinoderms

I. General Characteristics:

A. Spiny-skinned animals.

B. Their bodies are made up of like parts around a common center.

C. Most of the echinoderms have five arms or rays.

D. Move about very slowly.

E. A few forms are attached to rocks or other supports.

F. Feed on other sea life such as oysters and clams.

G. There are over 5,000 known species.

H. They have the power of regeneration. (Replace any part which may be eaten by some other animal or get caught under a rock or in the shell of a large clam.)

II. Types of Echinoderms:

A. Starfish.

B. Sea Urchins.

C. Sand Dollar.

D. Brittle Star.

E. Sea Cucumber.

F. Sea Feather.

G. Sea Lilies.

H. Florida Star.

III. Life History-----Reproduction:

A. Eggs after fertilization develop into free swimming marine animals.

B. The free swimming animals develop into very small animals the same shape as the adult. Some go through a free swimming metamorphic stage before taking the shape of the adult.

C. They live on small marine life.

IV. Habitat:

A. Live in salt water near the shore line.

B. Found mostly around rocky and sea-weed covered coast.

C. Starfish are found near oyster and clam beds as these form their main sources of food.

V. Economical Importance:

A. Very little importance to man for food. Some forms of echinoderms are eaten in China and the south Pacific Islands.

B. Starfish causes millions of dollars of damage to oyster beds each year.

C. Are collected for science experimentations or for science collections.

VI. References:

A. Science Guides:

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Powers, S. R.; Neuner, E. F.; and Bruner, H. B. This Changing World, Boston: Ginn and Co., 1935.

Ricketts, E. F., and Calvin, F. A. Natural History of Pacific Shore Invertebrates, Stanford University Press, 1935.

Russell, F. S. The Seas, New York: Fredrick Warne and Co., 1928.

Segmented Worms

(Annulata)

I. General Characteristics:

A. Have bodies that are made up of ring-like sections called segments.

B. The annelids mark an advance in the animal kingdom for we find the first animals adapted to life on land.

C. Very few of the annelids are parasitic.

D. There are over 4,000 known species.

E. Their bodies have alimentary canals or food tubes, a rather complicated nervous system, and a complete blood system.

F. They have the power of regeneration.

II. Types of segmented worms:

A. Earthworm.

B. Sandworm.

C. Clam Worm.

D. Sea Mouse.

E. Leeches.

III. Life History-----Reproduction:

A. The earthworm has both male and female sex cells present.

B. There is an exchange of sperm cells between two worms by copulation.

C. The sperms are placed in four little sacs on the under side of each worm.

D. A swollen area called the clitellum forms into a girdle. As it passes toward the anterior end (front part of worm), it receives from body openings the eggs (14th segment) and the sperms (9th and 10th segments) received and stored from the other earthworm.

E. The fertilized eggs are left to hatch in the ground or manure pile.

IV. Habitat:

A. The earthworm lives in the ground.

B. Many species live in fresh or salt water.

C. The leeches attach themselves to fish, frogs, small mammals, and man long enough to suck a meal of blood.

V. Economical Importance:

A. The earthworm is the only one of any importance.

B. Eats decaying vegetable matter.

C. Transfers rich soil to the top of the ground.

D. Their burrows admit air to the soil.

E. Serve as food for birds, insects, reptiles, and amphibians.

VI. References:

A. Science Guides:

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B. Books:

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Ward, H. B., and Whipple, G. O. Fresh-water Biology, New York: John Wiley & Sons, Inc., 1918.

Arthropoda

I. General Characteristics:

A. Have jointed legs and segmented bodies.

B. Have an exoskeleton mostly all lime and rather hard.

C. There are over a million species of arthropods.

D. The arthropods are ancient animals. They lived on this earth three hundred million years ago.

E. The exoskeletons are shed and new ones are developed as they grow larger.

F. Every arthropod has a segmented body.

G. Attached to many of the segments are one or more pairs of jointed appendages, as wings or legs.

II. Types of Arthropods:

A. Crustacea:

1. Lobsters.
2. Crabs.
3. Shrimps.
4. Barnacles.
5. Crayfish.
6. Sowbugs.
7. Pillbugs.
8. Prawns.

9. Cyclops and Copepods.
10. Water Fleas.

B. Arachnids:

1. Spiders.
2. Harvestmen.
3. Mites.
4. Ticks.
5. Scorpions.

C. Myriapods:

1. Centipedes.
2. Millipedes.

D. Insects:

1. Coleoptera Beetles and fireflies.
2. Diptera: flies, mosquitoes, and gnats.
3. Ephemerida: mayflies.
4. Hemiptera: chinch bugs and squash bugs.
5. Homoptera: cicadas, plant lice, and scale insects.
6. Hymenoptera: Bees, ants, wasps, gall, and ichneumon flies.
7. Lepidoptera: moths and butterflies.
8. Neuroptera: ant lions and dobson flies.
9. Odonata: dragon flies and damsel flies.
10. Orthoptera: grass-hoppers, crickets, and cockroaches.
11. Siphonaptera: fleas.

12. Trichoptera: caddis flies.

13. There are many more less common insect groups.

III. Life History-----Reproduction:

A. Crustacea:

1. Eggs laid and then fertilized by the male sperm from the outside.

2. Eggs remain attached to the outside of the female until they are hatched.

3. The small free swimming crustacea shift for themselves after hatching.

4. They live on dead material and so live wherever it is possible to catch it.

5. Most crustacea have two parts to the body:

a. head-thorax in one.

b. Abdomen.

6. Have from five to thirty pairs of legs.

7. Most all breathe by means of gills.

B. Arachnids:

1. Have two parts to the body:

a. head and thorax united as one.

b. abdomen.

2. Have four pair of legs and no antennae.

3. Have a stinging part which is painful and slightly poisonous.

4. Have no wings during life cycle.
5. Male and female are separate animals.
6. Eggs are fertilized by copulation.
7. Laid eggs are kept in a web covered sac until the young have hatched.
8. The young have the same appearance as the adult. No metamorphic stages to its development.

C. Myriapods:

1. Has a head and the body or abdomen.
2. Separate sex and eggs are fertilized as in the arachnids.
3. No stage of metamporphises during the life cycle.
4. There are two types:
   a. Millipeds--root feeders.
   b. Centipeds--insect feeders.

D. Insects:

1. Have three parts to the body:
   a. head.
   b. thorax.
   c. abdomen.
2. Complete metamorphic life cycle:
   a. eggs.
   b. larva.

c. pupa.

d. adult.

3. Male and female are separate animals and fertilization takes place by copulation.

4. Insects have wings in most species sometime during their life cycle.

5. Insects have only three pairs of legs.

IV. Habitat:

A. Found all over the earth:

1. In water.

2. In and on top of the ground.

3. In air.

V. Economical Importance:

A. To help with the fertilization of plants.

B. Some eat other arthropods.

C. For scientific investigation.

D. For beauty.

E. For creative designes of clothing and art.

VI. References :

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Russell, F. S. The Seas, New York: Fredrick Warne & Co., 1928.

Mollusca

I. General Characteristics:

A. Are soft bodies, unsegmented animals which are usually enclosed in a shell.

B. Every mollusk has an organ called a foot, which is used for:

1. Locomotion.
2. Digging.
3. Swimming.

C. Are used by man for food.

D. There are over 60,000 species known.

II. Types of Mollusks:

A. Snails--fresh and salt water and land.

B. Garden Slugs--land.

C. Clams and Oysters.

D. Squid, octopus, and cuttlefish.

E. Sea Mussels.

F. Abalone.

G. Chiton.

III. Life History-----Reproduction:

A. Most mollusks lay eggs which either pass through a metamorphic stage while some develop as likeness of parents as soon as they hatch.

B. Many develop as free swimming for a certain

length of time during their younger life's development.

IV. Habitat:

A. Most mollusks live either in fresh or salt water and have either lungs (those of the land) or gills (those of the water) for breathing.

B. The land and water species live on dead or living plant material and on dead or decayed animal matter.

V. Economical Importance:

A. Oysters are the most valuable of all sea products.

B. Marine clams, scallops, and abalones are used as food for human beings.

C. Snails and periwinkles are eaten by European people.

D. Squids are eaten in China. They are sold as "ink-fish" in the markets of the United States for food.

E. Until lately buttons were made from shells of clams, mussels, and abalones.

F. Pearl oysters of the tropical seas are very valuable for jewelry.

VI. References:

A. Science Guides:

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Chordata

(Vertebrates)

I. General Characteristics:

A. The bony material or skeleton is on the inside.

B. The skeleton is divided into two parts:

1. Axial skeleton, consisting of the skull and vetebral column.

2. Appendicular skeleton, consisting of two pair of limbs.

C. The vertebral column and skull protect the delicate spinal cord and brain.

D. The limbs support the body and aid locomotion.

E. Invertebrates were on the earth many ages before there were any vertebrates.

F. Man himself is a vertebrate.

G. There are over 36,000 known species of vertebrates.

II. Types of Vertebrates:

A. Pisces or fishes.

B. Batrachia or amphibians.

C. Reptila or reptiles.

D. Aves or birds.

E. Mammalia or mammals.

III. Life History-----Reproduction:

A. Some hatch their young from eggs.

B. Some young are born undeveloped and continue to grow in a pouch.

C. Many are born by the parent and pass through a helpless baby stage before becoming adults.

IV. Habitat:

A. Vertebrates are found in the air, on the surface, under the ground, and in the water.

B. Vertebrates live in tropical, temperate, and freezing climatic zones.

C. Some have a diet of animals, others of plants, and many of both animal and plant life.

V. References:

A. Books:

Anthony, H. E. Field Book of North American Mammals, New York: G. P. Putnam's Sons, 1928.

Dickerson, Mary. The Frog Book, New York: Doubleday, Doran & Co., Inc., 1920

Ditmars, R. L. The Book of Living Reptiles, New York: Doubleday, Doran & Co., Inc.,

Hegner, R. W. College Zoology, New York: The Macmillan Co.,

Jordan, D. S., and Evermann, B. W. American Food and Game Fishes, New York: Doubleday, Doran & Co., Inc., 1920

Kindsay, A. W. The Science of Animal Life, New York: Harcourt, Brace & Co.,

Pisces or Fish

I. General Characteristics:

A. Most fish have scales over their skin and fins for travelling.

B. Breathe by means of gills.

C. Their bodies are more or less flat and taper toward both ends.

D. They are "streamlined" with no projecting shoulders or hips to increase friction with the water.

E. The slimy covering over their bodies decreases friction when swimming.

F. They have an organ filled with air, called an air bladder which acts as a float.

G. Have fins for:

1. swimming.
2. guiding.
3. stopping.
4. balancing.

H. They have senses of see, hear, taste, smell and touch.

I. There are over 20,000 species of fish.

II. Types of Fish:

A. Elasmobranch: fishes which have a soft skeleton made of cartilage and have exposed gill slits:

1. Sharks.
2. Skates.
3. Rays.

B. Ganoid: fishes which once were very numerous on the earth, but which are now almost extinct. They are protected by platelike scales:

1. Gars.
2. Sturgeon.
3. Bowfins.

C. Dipnoan or Lung Fishes: a very small group. They are more like amphibians than fishes. The swimming bladder is used as a lung:

1. Lung fish of Africa.
2. Lung fish of South America.
3. Lung fish of Australia.

D. Teleostans or Bony Fishes: which composes 95% of all living fishes. The eggs are numerous. Most of our common food fishes belong to this class::

1. Cod.
2. Salmon.
3. Halibut.
4. Catfish or Bullhead.
5. Carp.
6. Pike.
7. Stickleback.
8. Bass.
9. Sunfish.
10. Perch.
11. Suckers.
12. Mosquito Fish.
13. Trout.
14. Goldfish.

III. Life History-----Reproduction:

A. Some fertilize their eggs by copulation and the young are born alive from the parent.

B. The bony fishes most all lay eggs which are fertilized afterwards by the milt of the male.

C. The average fish will lay hundreds of eggs in one season.

D. The young hatch as miniature adult shaped fish.

E. Many of the total amount of eggs do not hatch because of unfertile or are eaten by other marine life.

F. The young fish are eaten by their parents or by other marine creatures.

IV. Habitat:

A. Live in fresh or salt water.

B. Rocky or plant covered habitats are used for protection or for food hunting.

C. Many types of fish travel in large schools.

D. Usually fish will travel great distances, sometimes thousands of miles, during spawning time.

V. Economical Importance:

A. Food for all types of animal life.

B. Many types are used for fertilizers.

C. Some fish are caught chiefly for oil and glue.

D. The liver of most all large fish is made into "Cod-liver" oil.

E. Isinglass is made from the air bladder of sturgeon, cod, and other large fish.

F. Many fish caught off the coast of Norway are skinned and this is made into leather. Shark skin is used for women's shoe leather in the United States.

VI. References:

A. Science Guides:

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Stoye, F. H. Tropical Fishes for the Home, Their Care and Propagation, 37 Murray Street, New York: Empire Tropical Fish Importing Co., 1935.

Batrachia or Amphibian

I. General Characteristics:

A. Skin is moist or slimy and has no scales.

B. Are gill and lung breathers during their life cycle.

C. Oxygen of the adults is taken through the moist skin as well as through its lungs. This makes it possible for amphibians to remain under water for long periods of time.

D. Their main types of food are insects and worms.

E. The frog is well provided with sense organs: eyes, ears, touch, and to a small degree taste and smell.

F. Some of the amphibians resemble snakes while others look like lizards.

G. All amphibians go through a complete metamorphoses.

H. Amphibians hibernate during the winter in mud or damp places and breathe through their skins during this period.

I. The heart has three chambers: two auricles and one ventricle.

J. There are about 1,500 known species.

K. All amphibians have four legs.

II. Types of Amphibians:

A. Urodela: tail persistent throughout life:

1. Pacific Coast Newts.
2. California Tiger Salamander.
3. Marbled Salamander.
4. Tree Salamander.
5. Slender Salamander.
6. Oregon Salamander.
7. Mud Puppies.
8. Mud Eels.

B. Unura:

1. California Toad.
2. American Toad.
3. Western Spadefoot Toad.
4. Pacific Tree-toad.
5. California Red-legged Frog.
6. California Yellow-legged Frog.
7. Leopard Frog.
8. Bull Frog.

III. Life History-----Reproduction:

A. Most all amphibians lay eggs which are fertilized by the male afterwards.

B. The land forms lay the eggs in damp places where the entire development takes place within the egg and miniature adults hatch.

C. The water forms lay their eggs in the water:

1. Salamanders and frogs in round jelly masses attached to marine plant life.
2. Toads lay their eggs in a long jelly mass which is more than a year long. (Some lay over 6,000 eggs at once).

D. As soon as the eggs are laid into the water the jelly absorbs water and the eggs swell to ten times their normal size.

E. As the small tadpoles develop the jelly is used for food as well as protection.

F. Soon the tadpole wiggles free of the jelly and attaches itself to some water weed which it begins to eat.

G. The tadpole feeds upon algae and other water plants.

H. The tadpole breathes by means of gills.

I. Soon legs appear and the tail becomes shorter and shorter.

J. The gills are replaced by lungs and the amphibian comes to the surface for air.

K. The long coiled intestine becomes shorter and the amphibian begins to look for insects and worms as food.

L. After this development we have the adult which in two or three years will be full grown and ready to lay eggs.

IV. Habitat:

A. All live either in the water, on land, or in damp moist places.

V. Economical Importance:

A. Frogs eat harmful insects and worms.

B. Toads live in gardens and not only digs up the soil but eats insect pests and worms:

1. As many as eighty-three species of insects have been found in the stomachs of toads.

2. One toad ate in one summer twenty dollars worth of cutworms.

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A. Science Guides:

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B. Books:

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Reptilia or Reptiles

I. General Characteristics:

A. Reptiles have scales developed from the skin.

B. Reptiles always breathe by means of lungs.

C. They have the same temperature as their surroundings.

D. Reptiles hibernate during the cold winter months.

E. There are about 6,000 known species.

F. Many reptiles are harmless and make good pets.

G. The only poisonous lizard in the United States is the Gila Monster.

II. Types of Reptiles:

A. Chelonia: flattened reptiles with body inclosed in bony cases. They have no teeth or breastbone.

1. Tortoises.

2. Terrapins.

3. Turtles.

B. Lacertilia: body covered with scales, usually having two-paired appendages.

1. California Horned Toad.
2. Western Skink.
3. Alligator Lizards.
4. Brow-shouldered Utas.
5. Desert Scaly Lizard.
6. Leopard Lizard.
7. The chuckawalla.
8. Gila Monster (Poison).
9. Silvery Footless Lizard.

C. Ophidia: body elongated, covered with scales.
No limbs present.

1. Poisonous Snakes:
   a. Rattlesnakes.
   b. Copperhead.
   c. Water moccasin.
   d. Coral Snake.
2. Non-poisonous Snakes:
   a. Coral King Snake.
   b. King Snakes.
   c. Gopher Snakes.
   d. Garter Snakes.
   e. Racer Snakes.
   f. Pacific Rubber Snakes.

D. Crocodilia: fresh-water reptiles with elongated body and bony scales on the skin. They have two pairs of limbs.

1. Alligators.

2. Crocodiles.

III. Life History-----Reproduction:

A. Most reptiles lay eggs, which resembles bird's eggs which are covered with a leathery shell.

B. Some reptiles bear their young, such as the rattlesnake, gartersnake, alligator lizard, and the horned toad.

C. After the eggs are laid most species leave them to hatch and care for themselves.

IV. Habitat:

A. Reptiles are found all over the surface of the earth.

B. Reptiles can live in very dry areas or in very damp areas.

C. Snakes cannot stand the hot, direct sun on their bodies.

D. Snakes can swim on top or under the water. Many such species live on small fish, amphibians, mammals, and water birds.

V. Economical Importance:

A. Destroy harmful insects, mammals, and worms.

B. Turtles, lizards, and some snakes are used for food.

C. Skins of snakes, lizards, alligators, and crocodiles are used for leather.

VI. References:

A. Science Guides:

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Aves or Birds

I. General Characteristics:

A. Birds are "winged creatures with feathers".

B. The bones of birds are hollow.

C. There is an air sac inside the body cavity to give buoyancy when flying.

D. The body is conically-shaped.

E. The tail acts as a rudder.

F. The bill is horny and adapted for securing food.

G. The legs are used for running, perching, scratching, and swimming.

H. Waterproof feathers by means of oil gland on the tip of the tail.

II. Types of Birds:

A. Ratitae: running birds with no keeled brest-bone.

1. Ostrich.

2. Cassowary.

B. Passeres: perching birds; having three toes in front, one behind. Over one half of all apecies of birds are included in this order.

1. Sparrow.

2. Thrush.

3. Swallow.

C. Gallinae: Strong legs, feet adapted to scratching. Beak stout.
   1. Jungle fowl.
   2. Grouse.
   3. Quail.
   4. Domestic fowl.

D. Raptores: birds of prey. Hooked beak, strong claws.
   1. Eagle.
   2. Hawk.

E. Limicolae: shore birds, wings long, thin, flat, and pointed. Legs usually very long.
   1. Plover.
   2. Snipe.
   3. Sandpiper.

F. Longipennes: divers and swimmers with short legs and webbed toes.
   1. Gulls.
   2. Terns.

G. Columbae: like gallinae, but with weaker legs.
   1. Pigeon.
   2. Doves.

H. Pici: two toes point forward, two backward, and adaptation for climbing. Long, strong bill.

1. Woodpeckers.

2. Flickers.

I. Psittaci: hooked beak and fleshy tongue.

1. Parrots.

J. Coccyges: birds with powerful beaks, using their feet as a means of progression.

1. Kingfisher.

2. Toucan.

3. Cuckoo.

K. Macrochires: birds having long, pointed wings, without scales on metatarsus.

1. Swift.

2. Humming bird.

3. Goatsucker.

L. Anseres: birds with four toes, front ones fully webbed, tail not always well developed, bill with toothlike projections along its sides.

1. Ducks.

2. Geese.

3. Swans.

III. Life History-----Reproduction:

A. Eggs are laid and cared for by both male and female.

B. The young needs to be feed and protected during a certain part of the early life.

IV. Habitat:

A. Birds live in all parts of the earth.

B. Many live and nest in the open fields or on the prairies.

C. Others in the deep, thick, wooded areas.

D. Many water birds live near the water during their entire life.

V. Economical Importance:

A. Food for man and other animals.

B. Birds eat many types of harmful insects.

C. Are very important for their songs and beautiful colors.

D. Some birds are killed for their feathers which are used on women's hats.

E. Birds eat hundreds of harmful seeds each year.

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A. Science Guides:

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Mammalia or Mammals

I. General Characteristics:

A. Mammals are warm blooded, have a four chambered heart, a diaphragm, and well-developed lungs.

B. Have a hairy covering at some stage during their lifes history.

C. The young are nourished on milk secreated by glands known as the mammary glands.

D. Have a high type of mental development.

E. Breathe by means of lungs.

F. The young are born and resembles the parents.

II. Types of Mammals:

A. Monotremata: egg-laying animals. They hatch their young from eggs, but feed the young on milk. Natives of Australia.

1. Duckbill or Platypus.

2. Echidna.

B. Marsupialia: young born undeveloped and carried in pouches where the mammary gland is found.

1. Kangaroo.

2. Opossum.

C. Edentata: partly toothless mammals. These are all slow-moving animals. They feed on insects, worms, and plants. They are found chiefly in the tropics.

1. Sloth.
2. Anteater.
3. Armadillo.

D. Cetacea: water-inhabiting mammals. The legs are modified to serve as paddles.
1. Whale.
2. Porpoise.
3. Seal.

E. Sirenia: such as the sea cow.

F. Ungulata: hoofed mammals the teeth are adapted for eating grass and other plants. The legs are specialized for rapid locomation. They walk on the tips of their toes.
1. Odd-toe: horse..
2. Even-toe: cow, deer, pig, ox, and sheep.
3. Proboscidea: Having trunks like the elephants.

G. Rodentia: gnawing mammals.
1. Rats.
2. Beavers.
3. Squirrels.
4. Muskrats.
5. Rabbits.

H. Insectivora: insect-eating mammals. All the members of this group are small animals adapted for burrowing in the soil.

1. Moles.
2. Shrews.

I. Chiroptera: flying mammals. The bones of the front legs are greatly lengthened to support wings of thin tissue. Most bats feed on insects and bruit.

1. Bats.

J. Carnivora: flesh-eating mammals. These animals have long sharp teeth adapted to seizing and killing their prey.

1. Dogs.
2. Cats.
3. Bears.
4. Seals.

K. Primates: errect mammals. These mammals have more highly developed brains than any other animals. The front limbs of most primates are used for holding and grasping objects.

1. Lemuroidea--as marmosets.
2. Cebidae--as New World monkeys.
3. Cercopithecidae--as Old World monkeys.

4. Simiidae--as manlike apes.

5. Hominidae--as the human race.

III. Life History-----Reproduction:

A. Most mammals are born as miniature likenesses of the parents.

B. The young are very helpless and are taken care of for a long part of their youth.

IV. Habitat:

A. Mammals live in the water, on the earth's surface, and in the air.

V. Economical Importance:

A. For Food.

B. Beast of burden.

C. Skins for leather.

D. Furs, wool, and hair for clothing.

VI. References:

A. Science Guides:

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PLANTS

Thallus Plants or Thallophytes

I. Algae:

A. Green Algae:

1. Pleurococcus: shaded sides of tree trunks, rough posts, and rocks.
2. Ulothriz: grows attached to stones and sticks in fresh water.
3. Spirogyra: found floating in unattached masses on the surface of fresh water. Often known as frog slime or frog spittle.
4. Vaucheria: large enough to be seen by the naked eye. This plant also grows submerged in water.

B. Brown Algae:

1. Sea Colander.
2. Gulf Weed.
3. Rockweed.

C. Red Algae:

1. Irish Moss.

II. Fungi:

A. Bacteria.

B. Yeasts.

C. Bread Mold.

D. Water Mold.

E. Sac Fungi:

1. Peziza.

2. Powdery Mildew.

3. Dry Bread Mold.

4. Rust.

F. Toadstools, puffballs, and mushrooms.

III. Lichens:

A. Crustose: forming flat growths on rocks, trees, and old longs.

B. Thallose: are more or less leaf-like grow at right angles to the surface at both sides.

C. Fructicose: hanging pendent from trees or other substrates to which they are attached at only one point.

IV. References:

A. Science Guides:

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Ward, H. B., and Whipple, G. C. Fresh-Water Biology, New York: John Wiley and Sons, Inc., 1918.

Bryophytes

I. Mosses:

A. Moss plants bear spores as do the ferns but they produce them in a special case called a "capsule".

B. Instead of roots, mosses have single-celled rhizoids.

C. Mosses have true leaves which are fastened to the stem.

D. One interesting property of mosses is that of reviving during a shower and taking up life where the process was almost stopped by drought.

II. Liverworts:

A. A bit of delicate green tracery on a moist tree trunk.

B. Liverworts are very sensitive to drought and need more water than mosses.

III. References:

A. Science Guides:

Howe, J. W. Ferns, Mosses, Lickens, and Related Plants, Vol. 3, No. 4 November, 1936.

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B. Books:

Bergen, J. Y., and Caldwell, O. W. Practical Botany, Boston: Ginn and Co., 1911.

Dunham, E. M. How to Know the Mosses, Boston: Houghton Mifflin Co., 1916.

Gray, Asa. Outline of Botany, New York: American Book Co., 1895.

Grout, A. J. Mosses With a Hand-lens, New Brighton, Staten Island: A. J. Grout, 1924.

Pteridophytes

I. Ferns:

A. Deer Fern.

B. Sword Fern.

C. Five Finger Fern.

D. California Maiden Hair Fern.

E. Woodwardia or Chair Fern.

F. Lace Fern.

G. Bird's Foot Fern.

H. Coffee Fern.

II. Horsetail:

A. Horsetails are first cousins of the ferns for they have a similar life history.

B. One distinctive characteristic of many horsetails is the production of two kinds of shoots:

1. A sterile green shoot which makes food.

2. A fertile brown shoot which bears spores.

III. Club Moss:

A. The club mosses are small semi-prostrate species rarely growing more than one foot high.

B. Their foliage is collected, dried, and stained for use in decorations.

IV. References:

A. Science Guides:

Howe, J. W. Ferns, Mosses, Lichens, and Related Plants, Vol. 3, No. 4, November, 1936.

B. Books:

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Roberts, E., and Lawrence, J. American Ferns, New York: The Macmillan Co., 1935.

Spermatophytes or Seed Plants

I. Conifers:

A. Since conifers are the oldest of our living trees when arranged on an evolutionary scale, we will consider them first.

B. The conifers belong to the Gymnosperms (naked-seed) whose seeds are borne naked on the cone scale.

C. The cones remain closed tightly until the seeds are ripe.

D. The opening process can be reversed for a class exercise by soaking old, dry cones in water. After a day or so they will be closed as tightly as they were when still green on the tree.

E. A few conifers which belong to the Juniper family produce berry like fruits which are not like cones.

F. The leaves of all of our conifers are needle like affairs which seem like little more than the flattened midribs of broad leaves.

G. All the conifers have a thick, pleasant smelling sap often spoken of as resin.

H. Types of Conifers:

1. Pines.
2. Spruces.
3. Hemlocks.
4. Firs.
5. Redwoods.
6. Cypress.
7. Larches.
8. Cedars.
9. Yew.
10. Junipers.

II. References:

A. Science Guides:

Brauer, O. L., and Others. Products of Wood and Similar Substances, Vol. 4, No. 7, February, 1938.

Graves, G. W. National and State Forests and Parks, Vol. 5, No. 4, November, 1938.

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Hall, H. M. A Yosemite Flora, San Francisco: Paul Elder and Co., 1912.

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Sudworth, G. B. Forest Trees of Pacific Slope, Washington: U. S. Forest Service, 1908.

Tresidder, M. C. The Trees of Yosemite, Stanford University Press, 1932.

III. Angiosperms or Common Seed Plants:

A. Include the broad leaved evergreens and deciduous trees.

B. The angiosperm trees mature their fruits in one season and therefore can drop their leaves.

C. They become dormant during winter without injury to their tissure.

D. The Angiosperms are divided into Dicotyledons and Monocotyledons on the basis of the number of seed leaves.

E. The Monocotyledonous Trees:

1. The leaves whose veins are parallel, and can be torn into strips.

2. The trunk is usually unbranched and bears a crown of leaves at the top.

3. The seeds are borne in pods which open allowing the seeds to fall close by.

4. Types of monocotyledons:

a. Yaccas.

b. Cat-tails.

c. Sedges.

d. Trilliums.

e. Orchids.

f. Bulb-plants.

g. Grasses.

h. Onions, etc.

F. The Dicotyledons:

1. Trees: (All but the conifers).

a. The seeds are found in capsules.

b. Can be separated into three groups:

(1) Catkins producers.

(2) Flowers with distinct petals.

(3) Flowers with petals joined together.

c. Types of trees:

(1) Willow.

(2) Poplar.

(3) Alders.

(4) Oaks.

(5) Walnuts.

(6) California Myrtle.

(7) California Laurel.

(8) Western Sycamore.

(9) California Buckeye.

(10) Madrono.

(11) Maple.

2. Shrubs and Bushes.

3. Wild Flowers.

4. Weeds.

G. References:

1. Science Guides:

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PHYSICAL

I. The Earth: (A Planet).

- A. Formation.
- B. Valleys.
- C. Plains.
- D. Plateaus.
- E. Deserts.
- F. Mountains.
- G. Volcanoes.
- H. Earthquakes.
- I. Glaciers.

II. Astronomy:

- A. Sun.
- B. Moon.
- C. Stars.
- D. Planets.
- E. Satellites.
- F. Asteroids.

G. Eclipses.

H. Comets.

I. Meteors.

III. Seasons:

A. Spring.

B. Summer.

C. Autumn.

D. Winter.

IV. Atmosphere: (Air).

A. Composition:

1. Gases.

2. Water Vapor.

3. Dust Particles.

B. Pressure.

C. Light.

D. Heat.

E. Warming of land, water, and air.

F. Temperature changes.

G. Water forms in the atmosphere:

1. Humidity.

2. Dew.

3. Frost.

4. Fog.

5. Clouds.

6. Rain.

7. Snow.

8. Hail.

9. Ice.

H. Winds and storms.

I. Weather and climate.

V. Hydrosphere: (Water on the Earth).

A. Oceans.

B. Lakes.

C. Rivers.

VI. Lithosphere: (Crust of the Earth).

A. Minerals:

1. Metal Ore.

2. Pure Metals.

3. How are they classified?

B. Rocks:

1. Igneous.

2. Sedimentary.

3. Metamorphic.

C. Soil:

VII. Fossils:

VIII. References:

A. Science Guides:

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Only the larger generalizations of the course of study have been given here. According to the class needs, the outline can be enlarged, contracted, or modified. New material may be introduced at any point where it is pertinent. A bird's-eye view of the whole field of science can be given an a far better conception of the relation of the various fields of science may be obtained from such an overview.

The author found that many children received a well rounded understanding of their local environmental resources and a better interpretation of the many fields of science which were to be offered them when then advanced on to high school or into adult life.

A general survey test was given to the children the first of each year who were starting the orientation class in science. During the year oral and written classroom tests were given on the subject matter of each generalization as it was finished. This information the author used to check the students' progress. At the end of the year's orientation course the same general survey text was given.

The results received ran about the same for all the classes taught by the author over the eight year period. These results are shown in Chapter V.

The next chapter will give a short description of the work which was covered after the orientation course during the eighth and last year of science for many rural elementary children.

CHAPTER V

WORK WHICH FOLLOWED THE ORIENTATION COURSE

The orientation course gave the children a general background of scientific facts and knowledges concerning their natural environmental resources which could be used over the long summer vacation. It was found that the orientation course opened their eyes to the abundance of plant, animal, and physical materials in their local surroundings.

Summer trips of one, two, or three days became a general activity of many boys and girls with their families. Many large families went to the mountains or to the sea coast because of the desire of their children to collect specimens or to see some of the many natural resources that they had called to their attention in the orientation course.

When school opened in the fall the author was kept busy finding table, shelf, and storage space for the variety of natural resources that had been collected by the children. The collections consisted of: pressed wild flowers to identify, dried skins of small mammals to stuff, bird eggs to seal and identify, insects to press and organize into collections, sea shells, parts of conifer trees, dried sea-weed, live snakes, water-dogs, frogs and tree toads, crayfish,

turtles, snails, caterpillars, small fish, ferns, mosses, rocks and minerals, jars of ants and termites, and small conifer trees. The author believes that the local environment presents a wealth of instructional material. To withhold these riches from the child is no longer tenable.

The needs for the preceding experiences in rural and urban school children to enlarge the school walls is well stated by Hockett and Jacobsen:

> One means of enlarging the school walls is to encourage pupils to bring into the classroom the objects and interest which concern them outside. Today, in contrast to the era described in the old rhyme, both teacher and children are delighted to have "Mary's little lamb" follow her to school in order that they may enjoy its antics and study it as the source of wool. Equally welcome are caterpillars and beetles, rocks, shells, stamps, and flowers. There is no living creature or inanimate object that a child can bring that does not possess potential curriculum value. The resourceful teacher recognizes that every tangible messenger from the world outside offers both a clue to the interest and experiences of pupils and an unspoken invitation to further their understanding of the world of nature and man. Many things can be brought to school if it is not "against the Rule."[1]

The stage was set for the second year's work in studying the children's local natural environmental resources. The children had found over the summer vacation that their local environment, as well as the foothills, the sea coast, and the mountains, was over flowing with resources that

[1] John Hockett and E. W. Jacobsen, Modern Practices in the Elementary School, 129.

could be used in the classroom.

The first two or three science lessons were used to discuss the experiences and adventures had by members of the class over the summer and looking at their variety of collections. Intangible experiences can be reproduced in words for the benefit of teacher and fellow pupils. "Through willingness to share and talk over pupils' out-of-school experiences, teachers are able to elevate tastes and standards so that the refining influence of the school is expended into the community."[1]

A survey was made to see what fields of science or special part of the natural environment the students would like to experience during the school year. The following wants and interests were listed:

1. Life cycle of local insects:
    a. California Oak Moth.
    b. Glovers' Silk Moth.
    c. Termites.
    d. Swallowtailed Butterfly.
    e. Monarch Butterfly.
    f. Mourning Cloak Butterfly.
    g. Sphinx Moth (Tomato Worm).

[1] Ibid.

II. The life cycle of amphibians:

a. Tree toad.

b. Bull frogs of the local creeks.

c. Garden toads.

d. Salamanders (water-dogs).

III. Construct and observe the following habitats:

a. Balanced winter garden.

b. Balanced aquarium.

c. Terrarium for amphibians, water plants, ferns, and mosses.

d. Terrarium for water snakes, amphibians, water plants, ferns, and mosses.

e. Terrarium for small snakes, lizards, turtles, and small bushes and trees.

f. Desert Terrarium for snakes, lizards, and cacti.

g. Observation Ant Home for an ant colony.

h. Observation Termite Home for a termite colony.

i. Screen cage and home for rats or mice.

j. Screen cage and home for birds.

k. Large screen cage for snakes and small rodents (keep in class only a short time).

IV. Birds of the Pacific Coast:

a. Adaptations:

1. Feathers.

2. Bills and feet.

3. Food.

b. Home life of birds:
    1. Nesting territories.
    2. Songs.
    3. Nest building and nests.
    4. Incubation of eggs and feeding of the young.
    5. Protection of the nest and the young.

c. The travels of birds:

d. Common birds of California lowlands:
    1. All-year-round residents.
    2. Summer residents.
    3. Winter residents and visitors.
    4. Transients.

e. Bird homes and some birds at home:
    1. Gardens, orchards, tree lined streets, and city parks.
    2. Open grasslands, meadows, and mustard patches.
    3. Brushy slopes, chaparral, and sagebrush.
    4. Oak Groves, and attendant wooded slopes.
    5. Sluggish valley streams or irrigation ditches bordered with willows, cottonwoods, box elders, etc.
    6. Canyon streams, bordered with alders, maples, etc.

7. Coniferous forests.
8. Fresh water marshes.
9. Salt water marshes.
10. Cliffs, banks, barns, and bridges.
11. Barren land, dry hill tops, rocky canyons, deserts, and oases.

V. Wild flowers of the Pacific Coast: (weeds).
   a. Collecting of all local and foreign species.
   b. Pressing and drying the flowers for future use and museum collection.
   c. Identification of flowers found.
   d. Painting of flowers in water color.
   e. Planting of wild flowers around the school and at home.
   f. Flower arrangement.

VI. Rock and Mineral collections for the school museum.

VII. Preserving small animals in formaldehyde for school museum.

VIII. The Solar System.

IX. Atmosphere, weather, and climate.

X. Ornamental Shrubs:
   a. History.
   b. Learning of commonly used ornamental shrubs and their names.
   c. Which shrubs may be used to beautify the

surroundings of the school ground and the children's homes.

d. The study of landscape gardening.

e. Plant introduction in California.

f. State wide historical records of trees and shrubs.

XI. School and home gardens:

a. Garden soils.

b. Indoor Gardens:

1. Seedage Gardens.

2. Cuttage Gardens.

3. Bulb Gardens.

4. Miniature Gardens.

5. Window Box Gardens.

c. Outdoor Gardens:

1. Vegetable Gardens.

2. Flower Gardens.

XII. Trees:

a. Common Broad-leafed Trees.

b. Native and Introduced Cone-bearing Trees.

c. Trees in general.

XIII. Spiders:

a. The activities of Spiders.

b. The families of Spiders.

c. Economic importance of Spiders.

XIV. West Coast Marine Shells:

a. Classifying Shells.

b. Collecting.

1. Chitons.

2. Bivalve Shells.

3. Tooth Shells.

4. Snail-like Shells.

5. Nautilus Shells.

c. Pupil Activities:

1. Collecting specimens.

2. Preparing specimens.

3. Conserving Shore Animals.

4. Conserving Shore Plants.

XV. Tide-Pool Animals.

XVI. Small Wild Mammals of California.

XVII. Desert Life.

XVIII. Mushrooms and Other Fungi.

XIX. Streams and Their Valleys

XX. Water, Its Conservation and Use.

Much of the second year's work was done in committees with each developing a unit or units along their interests in science. There were many individual interests developed at home and their collections were brought into the school room from time to time to show what progress had been made. If it were impossible to bring the home unit to school the class

would make scheduled visits to the homes of the class members.

As the different committees progressed within the classroom there were many discussions, reports before the class, much research, and keeping of records of all findings. Many times an art lesson would be integrated with the study of insects, wild flowers, trees, and birds.

Field trips were made to the near-by creek, to the river, or to the open fields. Many well planned trips were taken to the city parks and museums in Sacramento where lectures were given by the state forester, the head gardener, or the museum attendent. The children kept notes while on these field trips which could be used for class records and discussions.

Hockett and Jacobsen bring out the importance of the field trip in the following few lines:

Purposes and advantages of class trips:

1. Journeys into the outside world stimulate and extend children's interests.
2. Educational journeys provide first-hand experiences. These enrich children's concepts and associations, clothe with reality and more abstract experiences of reading and discussion, and develop independence of learning.
3. Properly used, class trips eliminate the break between in-school and out-of-school life, thus increasing the continuity of the learning processes. Hence they are profitably used to integrate school and community experiences.

4. Class trips provide noteworthy opportunities for training in citizenship, Cooperation, leadership, and followership must all be practiced during a well-planned trip.
5. Trips offer rare opportunities for growth of understanding between the teacher and pupils. While sharing the pleasures and interests of a trip, members of a group are inevitably drawn into more intimate acquaintance. The teacher begins to seem more a friend, less a task-master. He, in turn, discovers unexpected interests and possible talents in the hitherto difficult troublemaker of the class or in the child who seemed to have no interests."[1]

The author noticed after the orientation course and as the second year's work was well on its way that children, who before having any science training about their natural environmental resources had much leisure time on their hands, were now so busy enjoying the open country that they had very little time to waste. Even the parents of these children were enjoying the work of their children and were helping them collect and identify specimens. Many men or women who had no children in school would send or bring over personally snakes, bugs, frogs, plants, and worms to be identified. The author also found that these mothers, fathers, andother adults liked to come over so they could see what the children were doing, and maybe learn the name of some new specimen in their local natural environment.

As the work progressed possibilities and opportunities

[1] John Hockett and E. W. Jacobsen, Modern Practices in the Elementary School, 131-132.

multiplied. The children showed a great interest and gladly cooperated with each individual or group as something new was discovered or brought into the classroom. Parents became interested and often furnished material or co-operated with home experiments of their children.

One father said: "I've never stopped so many times in all my life for my two girls to jump out of the automobile and pick up rocks, flowers, frogs, ferns, and look in small streams along the road as we did last week end. It took us three times as long as it ever did before to get to our summer cabin. But I like it, and believe it or not, I'm beginning to see more plant and animal life around our home and summer cabin than I have ever before!"

Another father came to me with the following information about his young son who was trying to solve his chicken feed losses caused by rats. "Say, what is this you told my young son about keeping a snake or two in the feed sheds? Why I went in there the other morning to feed my chickens and there on the floor was a three foot long gopher snake and up on one of the shelves was a king snake just as long. Before I could kill them my son was in there and telling me how much I would be fined if I should kill them. Then he began to tell me about what good rat killers these snakes were and I let him keep them for awhile. Do you know, he picks them up and talks to them as though they were a cat or a dog?

Well when I was a boy we wouldn't think of picking a snake up. We always killed them."

The author was told by this same man a month after that there was not a rat on the ranch and that the boy was feeding the snakes to keep them in a healthy condition. So it was with nearly every father and mother, they too were beginning to learn more about their environment and for the first time live with their children. In many of the homes a warm companionship was developed between father and son as the science program and environmental study developed.

As the year's work progressed the suggested construction of winter gardens, aquariums, terrariums, ant colonies, termite nests, snake cages, bird cages, and desert habitat became a reality. The classroom became a living zoo, all but for the loud noises of the lions, tigers, and elephants. The author noticed that the room was not only visited by the rest of the upper grades, but also by the lower grade classes before school, during the noon hour, or during physical education in the afternoon. The science room was at the disposal of the other teachers when not used by the science classes.

Many times when a certain lower grade class was in the middle of some certain science unit the teacher would ask for one of the upper grade boys or girls to talk to them. The students would take his or her live animal, tree, flower,

rocks, or whatever it may be that would correlate with the unit studied and give a personal talk and demonstration to the lower grade students. This proved to be well liked by both the student giving the demonstration and the children of the lower grade classes.

The importance of the snake cages is well described by Marguerita Vierheller, daughter of the Director, Zoological Garden, Saint Louis, Missouri when she writes:

> The snake cages in the room deserves credit for the service it does for the children in the entire school. It not only supplements the child's school studies, but it can offer a wealth of new and desirable information.----------How many people have grown up with a horror of snakes which with age becomes almost uncontrolable! ----------The reptile cage does the child a very worthwhile service if it can give him some accurate knowledge of its occupants, can help to curb his horror of them, and can instill the idea in him of preserving some species instead of killing all.
>
> The child is able, by means of the living exhibits before him, to form a true, helpful, mental picture of the various species he is apt to meet.
>
> Aside from the information which the living wild animal life can give the child, it can also cause him to become interested in the animals themselves. When this sort of interest is aroused there is no end to the fruitful ideas and ideals which can be stimulated within him. The child, then, ceases to look upon animals as strange, dumb, amusing things, but begins to see them as something living like himself. He realizes that they, too, possess feelings and desires and that they respond to care just as he does. He learns that they need good food and fresh air and that even the wildest respond in some way to those who have been kind to them.[1]

[1] Eleventh Yearbook, Department of Elementary School Principal, 484-485.

One section of the classroom library was set aside for science reference material. This reference material, consisting of books, pamphlets, magazines, seed catalogues, guide books to national and state parks, photographs of animal and plant life, poem books covering natural environmental resources, music books with songs about nature, and many science books of high school and college reading level which were presented by many adults within the community. The reference material increased as the individual or group interests and units developed. In this way all the children of the class had a great wealth of reference matter at their disposal. The children did a great deal of corresponding for free material with zoological gardens, botanical gardens, state and national forest departments, University of California, Department of Agriculture, and many general biological supply houses.

There were a few reference books included which would cover the aesthetic values of nature. The author believes that too many purely scientifically trained people become so engrossed, in facts, that the beauty side is entirely lost. One of the first things anyone should have impressed upon him is the pure beauty of his surroundings. Then along with his scientific data he is better fitted to enjoy life.

Culbertson emphasized this importance when she wrote:[1]

> One function of elementary science is to help the child to enjoy and create beauty. Also, the child should be led to appreciate the beautiful. He must be led to see the beauty in a sunset, in a wind-tossed tree, in the dancing waves, or in a blossoming shrub. There is an art in arranging a few sprays of flowers. There is grace of movement in the flight of the swallow and the drifting clouds. Saturated with the beauty in his natural world, he must be led to desire beauty in his man-made world. There is a beauty to be found all around us; it needs but a seeing eye.

The author believes that much valuable time is wasted in testing, especially the children during the second year of their science adventures. The best test is what have the children received from their many contacts during their two years of science training in interpreting their local natural environmental resources? The author believes that the following outcomes are a very true test of the knowledge, interpretation, attitudes, and appreciations that school children receive:

1. They will develop the habit of looking for information at its source.
2. "Looking to proof for authority, instead of to authority for proof."[2]

[1] A. C. Culbertson, A Practical Survey of Elementary Science for the Supervisor and Teacher, (Master's Thesis, University of California) 1929.

[2] E. Laurence Palmer, Fieldbook of Nature Study, 6.

3. The child will maintain an open-minded attitude as to what constitutes truth.
4. They should feel at home with nature and feel as though they are a part of its vastness.
5. Children should gain a greater appreciation of their place in the scheme of the universe.
6. The appreciation attitude will be reflected in the activities of the students.
7. They should develop healthful out-door hobbies.
8. They should maintain a sympathetic and open-minded attitude towards the natural phenomena of their environment.
9. Find through their elementary contacts with nature that nothing can happen without a cause and that occurrences that seem strange and mysterious can always be explained by natural causes.
10. Disbelief in superstitions of any sort.
11. Be careful and accurate in observations.
12. The expressed enjoyment received by children when dealing with their local natural environmental resources.

These outcomes do not readily submit themselves to exact measurements and statistical treatment. But the observing teacher can be sure of their presence even when keeping close check on his or her own tendency of wishful-thinking in the matter of results.

CHAPTER VI

SUMMARY

A. The experience of the author in developing these two courses in introductory science over a period of many years and in several different localities, seems to warrant the following conclusions:

1. The average rural elementary school child has very little training to help him to interpret his local natural environmental resources.

2. Much of the science teaching has been slighted because of the teacher's horror of and general lack of interest in snakes, toads, frogs, insects, spiders, and poisonous plants.

3. Many teachers did not want their class room "messed-up" with science specimens or collections brought to school by the children.

4. Units of work in social science were the major interests of many rural teachers with very little emphasis given to science study other than the physical sciences.

5. The desire of many teachers to teach from a textbook or a day by day course of study resulted in very little nature study experienced by their students of the local environment.

6. Many school principals were of the "old school" who believed in reading, writing, and arithmetic.

7. Rural teachers going back to summer school and not working on advanced degrees would take "snap-courses" which would fill their six units of summer school required every three years by the local school board of education. How much better for the teacher and the children it would be if they would take such summer work as nature study of the open fields, science field trips, and nature interpretation courses.

8. Children were interested in their local natural environmental resources, if they were given just a little help or background in what to look for and how to use it to interpret, know, and appreciate its wealth of material.

9. Children needed to be orientated to their local natural environmental resources.

10. Children's interests in nature materials of the environment were in order of their importance: (1) animals, (2) plants, and (3) physical materials.

11. Children liked to collect and study animals because they were alive, they could touch them, they could watch them eat and grow.

12. Wild flowers were studied by most students because they were pretty, could press and identify them, and could plant and care for them in their gardens at home.

13. The more children knew about their local natural environment the more joy and pleasure they received from it during their week-ends and long vacations.

14. There was a closer relationship developed between children and their families.

15. Fathers, mothers, big brothers and sisters, and adults of the community became very conscious of the school's importance in adjusting the child to his local natural and social environment.

16. There developed a very close relationship between the adult population and the local school.

17. There was a demand by children of other schools where the survey tests were given by the author, to study about the natural environmental resources listed.

18. Many of the rural school teachers used the author's survey test for a starting point to launch a science program the following school year.

19. The county superintendent, rural supervisor, and county nurse never visited the school without visiting "your very interesting science room" before leaving.

20. Many teachers, principals, and parents from other school districts would visit the author's nature study classroom during the school year.

21. There is a definite need for children to have training in nature study before they are graduated from the eighth grade in rural and urban schools. This was needed because of early marriages or discontinuing of their formal school education after elementary graduation.

22. With the increase of leisure time for the child and the adult, nature has much to offer them in hobbies, hiking, fishing, collecting, or enjoying the beauty of nature in its vastness.

23. Due to changing social and economic conditions on the Pacific Coast there is an increasing demand for summer camps for rural and urban children during the summer vacations. The background suggested by the author will be needed and helpful to the children because most of the camps will be in the mountains, near rivers, or along the seashore.

24. There is a definite place in the school program for well planned field trips by the teacher and the children.

B. This course has already been shown to be flexible and adaptable to various conditions, but of his experiences

thus far the writer offers the following suggestions for further study:

1. A testing program that can be used to test the scientific attitudes and appreciations of a child derived through a study of his natural environmental resources.

2. A study of scientific attitudes: (1) how they can be acquired, and (2) how can they be tested once they have been acquired?

3. The proper grade placement of science materials and interests as long as the classroom teacher needs the "crutch" of a textbook and a day by day course of study.

4. A study to determine a method of teaching or how to bring out the importance of the aesthetic values in nature study and science.

5. A nature study program that could be used in summer camps of the Pacific Coast States.

6. Survey study of needs and requirements of managers, cooks, caretakers, and counselors for boy's or girl's summer camps of the Pacific Coast States.[1]

[1] The author was camp manager of the Sacramento City Y. M. C. A. Summer Camp at Echo Lake during the summer of 1940 and feels that there is a definite need for such a study.

C. Such a science course of study as is here recommended does not stand by itself but must be related to problems of administration and curriculum making, equipment and provisions for storage, and placement. Hence the following recommendations:

1. The school program should correlate the abundance of the local natural environmental resources within the school program.

2. Have many science and nature study books within easy reach of the students for reference work and identifications.

3. Have well planned field trips whenever the teacher or the students feel the need for them.

4. Make use of colored pictures in magazines and travel pamphlets to illustrate facts and the beauty of nature, and have a well organized filing system for the preservation of this material.

5. All teachers should be interested in science materials and collections brought into the school room by the children.

6. Each school room, whether it is for science, reading, spelling, music, or sewing, should have some plants and small animal life. This may be only a few potted plants or one small fish in a balanced aquarium.

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A P P E N D I X

APPENDIX

NATURAL SCIENCE SURVEY

NAME_____GRADE_____SCHOOL_____

The following questions are to test your knowledge of natural science in your community. Do not talk during this test, unless to ask directions from your teacher.

INSECTS

TRUE AND FALSE QUESTIONS:

_____1. The spider is an insect.

_____2. There are three parts to an insects body.

_____3. Ants and bees have well organized colonies.

_____4. There are no termites in the Sacramento Valley.

_____5. The ant is the greatest enemy of the termite.

_____6. Butterflies are usually brightly colored while moths are usually dull colored.

_____7. The house fly has an "L" shaped vein on each wing.

_____8. The cocoon is the nonliving part or case around the pupa or living insect.

_____9. Both the male and female mosquito has a stinging bite.

_____10. Some insects live and develop in the water before becoming adults.

_____11. The dragonfly lays its eggs by dipping the tip of its abdomen in the water.

_____12. Centipedes found in the Sacramento Valley are poisonous.

_____13. Dragonflies are good snake doctors.

_____14. A bee's stinger grows back.

_____15. Mosquitoes carry germs which are harmful to man.

COMPLETION QUESTIONS:

1. The complete metamorphois or life cycle of a butterfly is: 1)_____,2)_____,3)_____,4)_____

2. The Antenna of an insect are used for: 1)_____, 2)_____,3)_____.

3. The three parts of an insect's body are: 1)_____, 2)_____, 3)_____.

4. Name five butterflies that you know around your home or school: 1)_____,2)_____, 3)_____,4)_____,5)_____.

5. Where do butterflies and moths lay their eggs_____.

6. The Doodle Bug is found in_____.

7. The inhabitance of an ant colony are: 1)_____, 2)_____,3)_____,4)_____.

8. Termites eat _____and have _____that live in their intestines which help digest the wood eaten.

9. Ant cows are called_____.

10. Name ten harmful insects in your community: 1)_____, 2)_____,3)_____,4)_____,5)_____, 6)_____,7)_____,8)_____,9)_____, 10)_____.

11. The hair like feelers on the heads of insects are called: _____.

12. Grasshoppers lay their eggs in _____.

13. All insects have_____legs.

14. Name two social insects that live in colonies: 1)_____,2)_____.

MULTIPLE-CHOICE QUESTIONS: (Draw a circle around the right number)

1. Moths fly: 1) at night, 2) during the day, 3) both day and night.

2. Moths and butterflies bodies are covered with: 1) scales, 2) thin transparent layer of skin, 3) small hairs.

3. Butterflies have antenna that are:
   1) hair like b) fern like

4. Are you afraid of insects:

   1) Yes, why? _____

   2) No, why? _____

SPIDERS

TRUE AND FALSE QUESTIONS:

_____1. Spiders cannot see in back of them.

_____2. All spiders are poisonous.

_____3. The Tarantula of the Sacramento Valley is not poisonous.

_____4. Spiders are very helpful to the farmer.

_____5. All human beings are affected by the poison of the Black Widow Spider.

_____6. The female or mother spider usually eats the male or father.

COMPLETION QUESTIONS:

1. A spider has_____parts to its body. (Give the number).

2. Spiders have_____jointed legs. (Give the number).

3. The small spinning tubes at the end of the abdomen are called_____.

4. Spiders that build their nests in the ground and have very tight fitting doors are called _____.

5. Name five kinds of spiders found around your home: 1)_____,2)_____,3)_____,4)_____,5)_____

6. Are you afraid of spiders?

   a. Yes, why?_____

   b. No, why?_____

7. The _____spider carries the young on her back.

8. The web of the spider is used for _____ and_____.

MULTIPLE-CHOICE: (Draw a circle around the right number).

1. A spider has: 1) 6 to 8 eyes, 2) two large eyes, 3) four eyes.

2. Spiders have: 1) 4 legs, 2) 6 legs, 3) 8 legs.

3. The poisonous spider of the Sacramento Valley is the: 1) Garden Spider, 2) Black Widow Spider, 3) Tarantula.

4. A spider eats its food: 1) by chewing it up well before swallowing, 2) by crushing it first and then sucking the juices, 3) or, by swallowing the insect whole.

5. The male or father spider is: 1) larger, 2) smaller, 3) same size as the female.

REPTILES

TRUE AND FALSE QUESTIONS:

_____1. All reptiles are poisonous.

_____2. Snakes, turtles, and lizards belong to the reptile family.

_____3. All lizards in California are poisonous.

_____4. Snakes cannot be tamed easily.

_____5. Snakes and lizards are of no help to the farmer.

_____6. Reptiles never breathe through gills at any stage of their life.

_____7. There are no turtles in the Sacramento Valley.

_____8. There are forty-five species of lizards in California.

_____9. The King or Milk Snake have been know to steal milk from a cow.

_____10. Snakes cannot climb trees.

_____11. Horned Toads can spray small droplets of blood from their eyes.

_____12. A lizard's tail never grows back on once it falls off.

_____13. Snakes bite with their tongue.

_____14. If the fangs of a poisonous snake have been removed, it is safe to handle permanently.

_____15. A snake sheds its skin only once each year.

COMPLETION QUESTIONS:

1. Reptiles are divided into the following four groups:
   1)_____,2)_____,3)_____,4)_____

2. There are four kinds or families of poisonous snakes in the United States: 1)_____,2)_____
   3)_____,4)_____

3. Name five snakes that are native to your home community:
   1)_____,2)_____,3)_____,
   4)_____,5)_____

4. Snakes are helpful because they eat the following pests:
   1)_____,2)_____,3)_____,4)_____

5. The two most common lizards in the Sacramento Valley are:
   1)_____,2)_____.

6. The Pacific Mud Turtle protects itself from its enemies by_____.

7. The only poisonous snake found in the upper Sacramento Valley is the _____.

8. Most reptiles bodies are covered with_____.

9. The forked tongue of a snake is used for: 1)_____, 2)_____,3)_____.

10. A snake bites or strikes with its_____.

11. Snakes_____in the winter time when its colds.

MULTIPLE-CHOICE: (Draw a circle around one number.)

1. Most reptiles eat only: a) dead food, b) living food, c) living and dead food.

2. Are you afraid of snakes?

   a) Yes, why?_____.
   b) No, why?_____.

3. Do you have snakes around your house that you play with or use to catch rats and mice?

   a) Yes, why?_____.
   b) No, why?_____.

4. Are you afraid of lizards?

   a) Yes, why?_____.
   b) No, why?_____.

5. Did you ever have a lizard as a pet?

   a) Yes, why?_____.
   b) No, why?_____.

BIRDS

COMPLETION QUESTIONS:

1. Birds with hooked beaks usually eat_____.
2. Birds with short straight beaks usually eat_____.
3. Birds are so light in weight because their_____.
4. _____use their tails as props.
5. A _____is the only bird that can stay still in flight.
6. The bird that builds the most untidy nest is the_____.
7. A bird which builds a hanging nest is an_____.
8. Hawks are valuable because they eat many_____ and_____.
9. Birds have a great economic value because they eat_____ _____and_____.
10. Birds migrate to the _____in the fall and to the _____in the Spring.
11. Birds migrate in groups called_____.

MATCHING QUESTIONS:

1.	Smallest birds	_____Meadow Larks.
2.	The Bird that makes no noise when it flies.	_____Sparrow.
		_____Swallow.
3.	Nests on the ground.	_____Burrowing Owl.
4.	Small birds with redhead.	_____Humming birds.
5.	Bird which doesn't migrate.	_____Linnets.
6.	California State Bird.	_____Quail.
7.	Makes mud nest under eves and cliffs.	_____Owl.
		_____Killdeer.
8.	Lays eggs in rocks or hallow.	_____Heron.
9.	Lives in hole in ground.	_____Migration.
10.	Has red, orange and yellow patch on wing.	_____Red-winged Blackbird.
11.	Large wading bird of this region.	
12.	Birds moving to new sections of the country at certain seasons.	

AMPHIBIANS

TRUE AND FALSE QUESTIONS:

_____1. Salamanders are natives to the Sacramento Valley.

_____2. Toads give off a smelly, bad tasting fluid when harmed.

_____3. All amphibians pass through the polliwog stage.

_____4. All amphibians have the ability to hibernate.

_____5. Amphibian eggs are surrounded by a jelly mass that is used by the young for food.

_____6. Salamanders are poisonous to touch.

_____7. You get warts from toads.

_____8. Polliwogs tails drop off when they become frogs and toads.

_____9. Amphibians shed their skins.

_____10. Tadpolls eat algae.

COMPLETION QUESTIONS:

1. The three groups of amphibians are: 1)_____, 2)_____,3)_____.

2. Frogs change color for _____.

3. Toads and frogs eat_____.

4. Toads are easily distinguished from frogs because of their _____.

5. The hind legs of toads and frogs are _____ because they used for_____.

6. Amphibians catch insects with their_____.

7. Salamanders are sometimes called_____.

8. The salamanders are_____color on the stomach.

9. Tree toads climb because they have_____ on their toes.

10. _____are used as food for humans.

11. A toads tongue is attached to the_____ of his mouth.

MULTIPLE-CHOICE QUESTIONS: (Draw a circle around the right number.)

1. Adult frogs breathe by: 1) gills 2) lungs.

2. Toads and frogs eat: 1) dead things 2) living things.

3. The tails of tadpoles: 1) drop off 2) are absorbed and form the backbone.

4. The toad's eggs are laid: 1) in long jelly strings 2) in round jelly masses the size of a walnut.

5. Are you afraid of toads?

   a) Yes, Why?_____
   b) No, why?_____

6. Are you afraid of frogs?

   a) Yes, why?_____
   b) No, why?_____

FRESH WATER LIFE

TRUE AND FALSE QUESTIONS:

_____1. There must be a balance between plant and animal life in an aquarium or it will be filled with algae.

_____2. Water snails are scavengers.

_____3. Fish have eyelids.

_____4. The government has hatcheries to restock streams.

_____5. All fish lay eggs.

_____6. Catfish have tentacles which resemble whiskers.

_____7. Bass are shaped much like a trout.

_____8. Suckers are so called because of their mouth shape and eating habits.

_____9. Fairy Shrimps are good to eat.

_____10. Crayfish are good to eat.

_____11. If a leg of a crayfish is broken off it will grow a new one.

_____12. Hairsnakes come from horse hair put in water for a time.

COMPLETION QUESTIONS:

1. The green scum on water is called_____.

2. _____are good to have in a pond to eat mosquito larva.

3. Fish are covered with_____to protect them.

4. The _____ of a fish are used for steering.

5. While fish feed they face_____.

6. Catfish live on the _____of the river and are scavengers.

7. _____are the organs for breathing in a fish.

8. Small fish are called_____.

9. You can usually tell the male crayfish from the female by his _____.

10. The female crayfish carries her eggs (where)_____.

11. Name five fresh water fish in the creek or rivers close to your home: 1)_____,2)_____, 3)_____4)_____,5)_____.

MAMMALS

TRUE AND FALSE QUESTIONS:

_____1. Some gnawers of the mammal family are rats, squirrels, and beavers.

_____2. Meat eaters always have longer teeth on each side for tearing.

_____3. Skunks use their scent for protection.

_____4. Are Jack rabbits free from disease.

_____5. Squirrels and squirrel holes are breeding places for germs.

_____6. Moles skins are of no value.

_____7. Mice have furry tails.

_____8. Bats may fly through a room where strings hang and never touch one.

_____9. Bats can start to fly from the ground.

_____10. Bats feed on insects only.

_____11. Ground squirrels are good for fields because they keep the soil loosened up.

_____12. Opossums have migrated into California.

_____13. All mammals are warm blooded.

MATCHING QUESTIONS:

1. Large gray, bushy tail.
2. Blind burrower.
3. Long ears.
4. Small white tail.
5. Long hairless, pencil-like tail.
6. Garden burrower with vision.
7. Pest in some homes.
8. Very soft, short fine fur.
9. White stripe down back.
10. Bats
11. Mammals that sleep upside down.
12. Seen in most fields and on fence posts.

_____Mole.
_____Cotton Tail.
_____Mice.
_____Skunk.
_____Bats.
_____Gray Squirrel.
_____Gopher.
_____Ground Squirrel.
_____Jack Rabbit.
_____Flying Mammals.
_____Opossum.
_____Rat.
_____Mole.

13. Carries young on her back, tails curled over hers.

PLANTS AND WILD FLOWERS

TRUE AND FALSE QUESTIONS:

_____1. The Mariposa lillies from the Sacramento Valley are red.

_____2. Larkspurs are poisonous to eat.

_____3. Blow wives resemble dandelions.

_____4. The idea that nettles sting is silly or untrue.

_____5. Many of our wild flowers have migrated to Sacramento County from other States and Countries.

_____6. Many wild flowers and plants were formerly used for medicines.

_____7. All Brodiaeas are nearly blue in color.

_____8. Wild flowers are protected by law.

COMPLETION QUESTIONS:

1. The parts of a typical flower are: 1)_____, 2)_____, 3)_____, 4)_____, 5)_____, 6)_____, 7)_____, 8)_____, 9)_____, 10)_____, 11)_____

2. The stamens are the _____ (male or female) part of the flower.

3. The pollen is carried from one flower to another flower in the following ways: 1)_____, 2)_____, 3)_____.

4. Flowers attract insects to them by their_____ and _____.

5. Our state flower in California is the _____.

6. Wild flower seeds are scattered from place to place by the following ways: 1)_____,2)_____,3)_____.

7. When a wild flower or plant becomes_____we call it a weed.

8. The two most important parts of a complete flower are the 1)_____and 2)_____.

9. Name three yellow wild flowers: 1)_____, 2)_____,3)_____. Name three blue wild flowers: 1)_____, 2)_____,3)_____. Name three white wild flowers: 1)_____, 2)_____,3)_____. Name three pink or red wild flowers: 1)_____, 2)_____,3)_____, around your home.

10. Name the parts of an entire plant: 1)_____, 2)_____,3)_____,4)_____, 5)_____,6)_____.

11. The two types of roots are.: 1)_____,2)_____.

12. The very small roots of plants are called _____ roots.

13. Plants have roots for the following reasons: 1)_____, 2)_____,3)_____,4)_____.

14. Chlorophyll is the _____ in plants.

15. Leaves are important to the plant because: 1)_____, 2)_____,3)_____.

16. The reasons why plants develop seeds are: 1)_____, 2)_____,3)_____.

TREES

TRUE AND FALSE QUESTIONS:

_____1. Trees may have a disease.

_____2. Insects may destroy trees.

_____3. Brush and grass makes a forest safe.

_____4. Burbank did much work with trees and flowers.

_____5. Tree roots are valuable as flood preventors.

_____6. Peaches grafted on an almond tree would be good to eat.

_____7. All oak trees shed their leaves in the Fall of the year.

_____8. The stem of the tree is called the trunk.

_____9. Pussy willow, alder, and walnut trees have catkins in the Spring of the year.

_____10. The fruit of some trees are the seeds.

_____11. Acorns grow on birch trees.

_____12. There are only two kinds of willow trees.

COMPLETION QUESTIONS:

1. Four main values of trees are: 1)_____,2)_____, 3)_____,4)_____.

2. Trees may be divided into two large groups:
   a)_____(those that keep their foliage),and
   b)_____(those that shed their foliage).

3. Our largest forest menace today is_____.

4. It is alright to cut trees or timber if we_____ trees.

5. National and State Parks is one means of _____ of our forests.

6. The most common native tree in the Sacramento Valley is the_____.

7. English walnuts are usually_____onto the stumps of black walnut trees.

8. _____trees grow along most of our small creeks.

9. _____trees are grown in the Sacramento Valley for wind brakes.

10. The trunks of most trees is covered with_____.

11. After a tree has been cut down you can tell its age by _____the_____.

12. Trees may also be classified as _____and_____ wood trees.

WEATHER

TRUE AND FALSE QUESTIONS:

_____1. The sun has very little to do with the weather.

_____2. Air at sea level weighs about 14 pounds per square inch.

_____3. Warm air is very heavy.

_____4. Winds are caused by the heating of air, especially uneven heating.

_____5. Rain is caused by the uplift and cooling of cloud and air with resulting collection of water in larger and larger droplets about dust particles.

COMPLETION QUESTIONS:

1. The three factors which influence weather: 1)_____, 2)_____,3)_____.

2. The sun's rays are the warmest when_____.

3. The_____causes the changes or variations in the weather.

4. The three most important gases of the air are: 1)_____, 2)_____,3)_____.

5. The gas given off by plants is called_____and the gas given off by animals is called_____.

6. Colder air takes the place of_____air that has been heated by the sun.

7. Sunset colors are caused by the rays of the sun shinning through small_____in the air.

8. The chief sources of water in the air is_____, _____,_____, and _____.

9. When frozen cloud particles join together in flakes we have_____.

MULTIPLE-CHOICE QUESTIONS: (Draw a circle around the right number.)

1. Heat is absorbed or lost most quickly from the suny by: 1) the land, 2) the water, 3) the air.

2. When air is heated, it becomes: 1) heavier, 2) light, 3) remains the same weight.

3. Winds are caused by: 1) air that has been heating, 2) too many clouds, 3) by thunder.

4. The wind blows in the U. S. A. mostly from the: 1) East, 2) West, 3) North, 4) South.

SOIL

COMPLETION QUESTIONS:

1. The earth surface of the Sacramento Valley is always being changed by: 1)_____,2)_____, 3)_____,4)_____.

2. Soil is caused by _____ that have been broken up.

3. The humus in the soil is derived from the decomposition of 1)_____ and 2)_____.

4. When large cracks or canyons are washed in the dirt or mountains, we call it _____.

5. Name the kinds of soil around your home: 1)_____, 2)_____, 3)_____ 4)_____, 5)_____.

TRUE AND FALSE QUESTIONS:

_____1. The surface of the Sacramento Valley is always being changed.

_____2. All soils, even the driest, contain some water.

_____3. Certain animals, such as earth-worms and rodents, have contributed to the building of soil.

GENERAL QUESTIONS

COMPLETION QUESTIONS:

1. Would you like to know more about the animals, plants, and rocks around your home?

   a) Yes, why?_____
   b) No, why?_____

2. What in nature would you like most to study?_____
   _____

3. Do you like to collect plants?

   a) Yes, why?_____
   b) No, why?_____

4. Do you like to collect animals?

   a) Yes, why?_____
   b) No, why?_____

5. Do you like to collect rocks?

   a) Yes, why?_____
   b) No, why?_____

6. Where do you spend your vacations each year?_____